

Sustainability Outlook Indicator Descriptions and Methodology

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DRAFT

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About this Document

The Sustainability Outlook describes how, through the lens of four societal values — public health and safety, healthy economy, ecosystem vitality, and opportunities for enriching experiences — it will help identify desired water management outcomes and indicators. Those outcomes and indicators can be used to gauge the status of, and progress toward, sustainability. Because sustainability is not something achieved once and forever, the Sustainability Outlook and the representative indicators are intended to be adaptive and help water resource managers address changing circumstances and incorporate lessons learned.

This document details the process to date for developing the sustainability indicators and includes descriptions of the initial indicators. Indicators are presented according to societal value, corresponding intended outcome, and classification (“Basic” with potential statewide application or “Watershed” level application, “Advanced” for future development, or “Archived” with no additional development identified at this time). Each intended outcome has several indicators, and in some cases, indicators may apply to multiple outcomes.

This version of the document (December 2018) is being released concurrently with the public review draft of Update 2018. It is considered an in-progress review draft because indicator assessments are ongoing, and the contents are subject to change as indicators are more fully developed, combined, or otherwise modified. As part of Update 2018, future versions of this paper will reflect the status of indicator development and stakeholder input.

The document is organized as follows:

- **Section 1, Introduction to Sustainability Outlook and Indicators** — Provides background information and describes the four societal values, intended outcomes, and their relationship to the indicators.
- **Section 2, Methodology** — Describes development of the initial set of indicators being piloted at statewide and watershed scales.
- **Section 3, Screening Process** — Provides a description of the screening process for determining the status of each indicator (retained as a basic indicator, considered at a watershed-scale, advanced in the future, or archived).
- **Section 4, Basic and Watershed Sustainability Indicators** — Details the assessment of each Basic and Watershed indicator, including a description and introductory information, importance and screening considerations, initial data and results, recommendations, and references.
- **Section 5, Advanced (Future) Sustainability Indicators** — Details the assessment of each Advanced (Future) indicator, including a description and introductory information, importance and screening considerations, recommendations, and references.
- **Section 6, Archived Sustainability Indicators** — Describes the assessment of each Archived indicator, including a description, screening considerations, and justification for why the indicator is not supportive of the Sustainability Outlook evaluation.
- **Section 7, Current Statewide Sustainability Dashboard** — Summarizes the current evaluations of all the Basic and Watershed indicators to assess California’s progress toward sustainability and describes next steps in Sustainability Outlook development.
- **Section 8, References** — Provides a list of references used in development of the indicators.

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Abbreviations and Acronyms

AB	Assembly Bill
ATL	Advisory Tissue Level
AWMP	Agricultural Water Management Plan
Bay Area	San Francisco Bay Area
Cal EPA	California Environmental Protection Agency
Cal-Nemo	California Non-native Estuarine and Marine Organisms
Cal OES	California Governor's Office of Emergency Services
CalFire	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CANOD	California Aquatic Non-native Organism Database
CASGEM	California Statewide Groundwater Elevation Monitoring
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
CPI	Consumer Price Index
CSCI	California Stream Condition Index
CSU	California State University
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Project
CWP	California Water Plan
DDW	State Water Resources Control Board Division of Drinking Water
DWR	California Department of Water Resources
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FRAP	Fire and Resource Assessment Program
FRID	Fire Return Interval Departure
GAMA	Groundwater Ambient Monitoring and Assessment
GDP	Gross Domestic Product
GIS	Geographic Information System

GMP	Groundwater Management Plan
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IHCIA	Indian Health Care Improvement Act
IHS	U.S. Department of Health and Human Services, Indian Health Service
JPL	Jet Propulsion Laboratory
km ²	square kilometer
LCA	California Land Conservation Act
LCP	Local Coastal Program
Legislature	California State Legislature
MCL	maximum contaminant levels
NAS	Nonindigenous Aquatic Species
NASA	National Aeronautics and Space Administration
NCES	National Center for Education Statistics
NEMESIS	National Estuarine and Marine Exotic Species Information System
NHD	National Hydrography Dataset
NHP	National Historic Place
NM	National Monument
NOAA	National Oceanic and Atmospheric Administration
NRA	National Recreation Area
NRHP	National Register of Historic Places
OEHHA	California Office of Environmental Health Hazard Assessment
OWOW	One Water One Watershed
PAD	Passage Assessment Database
ppb	parts per billion
PPIC	Public Policy Institute of California
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SAWPA	Santa Ana Watershed Project Authority
SB	Senate Bill
SGMA	Sustainable Groundwater Management Act

SPFC	State Plan Flood Control
State Water Board	State Water Resources Control Board
SWAMP	Surface Water Ambient Monitoring Program
SWP	State Water Project
TAF	thousand acre-feet
TIGER	Topologically Integrated Geographic Encoding and Referencing
UC	University of California
Update 2013	California Water Plan Update 2013
Update 2018	California Water Plan Update 2018
USACE	U.S. Army Corps of Engineers
U.S. EPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WSCP	Water Shortage Contingency Plan

1 Introduction to Sustainability Outlook and Indicators

The long-term goal of the Sustainability Outlook is to establish a single comprehensive and practical method for tracking and reporting progress toward and effectiveness of implementing water management actions and policies that provide shared agreement and consistency across State government and local governments across California's diverse regions. California Water Plan Update 2013 (Update 2013) proposed the use of sustainability indicators to evaluate progress and return on State investments. California Water Plan Update 2018 (Update 2018) establishes methods for performance tracking through the identification of societal values that represent primary interests expressed by the water resource community, intended outcomes, and indicators. In acknowledgement of sustainability as an ongoing process, both the Sustainability Outlook and the representative indicators are intended to be adaptive and help water resource managers address changing circumstances and incorporate lessons learned.

Each sustainability indicator was assessed and evaluated against respective intended outcomes and societal values. As shown in Figure 1-1, there are four separate societal values: Public Health and Safety, Ecosystem Vitality, Healthy Economy, and Opportunities for Enriching Experiences. Each societal value has three or four associated intended outcomes.

This initial process to develop the sustainability indicators involved establishing definitions for sustainability in the context of four societal values; creating a framework for linking the values with the outcomes and those outcomes with the indicators; and developing desired outcomes and metrics for those values using existing information, such as Update 2013.

To provide a complete and thorough assessment of each identified sustainability indicator, this document summarizes the following information:

- Description
- Importance and Screening Considerations
- Initial Data and Results
- Recommendations
- References



Figure 1-1. The Four Societal Values used to Evaluate the Sustainability Outlook (Preliminary Graphic)

In this document, each indicator is presented by the associated societal value, a corresponding intended outcome, and whether or not the indicator is considered Basic/Watershed, Advanced, or Archived. Each intended outcome has several indicators. In some cases, while an indicator is presented under one corresponding outcome, it may provide insight into multiple outcomes.

1.1 Public Health and Safety

Public health and safety is defined as prevention of, protection from, and mitigation of events that could harm or injure people. Events that can pose a risk of harm or injury include accidents, outbreaks, illnesses, crimes, and disasters (natural or man-made). The vision for this societal value is that all Californians are protected from public health and safety threats and emergencies.

The intended outcomes that represent Public Health and Safety include:

- A reliable water supply for domestic needs, sanitation, and fire suppression;
- Reduced number of people exposed to waterborne health threats such as contaminants or infectious agents;
- Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure).

1.2 Ecosystem Vitality

Ecosystem vitality describes the healthy functioning and lasting resiliency of diverse communities of interconnected aquatic, riparian, and wetland organisms across California. Ecosystem resilience is defined as the ability of an ecosystem to withstand or respond to disturbances without undergoing major or irreversible changes in identity, function, or structure. The vision for this societal value is for thriving ecosystems to exist throughout the state.

The intended outcomes that represent Ecosystem Vitality include:

- Maintained and increased ecosystem and native species distributions in California while sustaining and enhancing species abundance and richness;
- Maintained and improved ecological functions and processes vital for sustaining ecosystems in California; and
- Achieved designated beneficial uses for water bodies throughout the state.

1.3 Healthy Economy

A healthy economy would include positive and responsible economic development; strong commitments to the long-term health of people and the environment; government encouragement of job-creating investments; and removal of excess regulations that may throttle economic development. A healthy economy is also stable, i.e., there are no excessive fluctuations in the macro economy and there is low inflation. In a healthy economy, all Californians would have opportunities to prosper through a combination of jobs, household production, entrepreneurship, and public services and would be engaged in the political and economic decisions that impact their health and happiness. The vision for this societal value is that California has a healthy economy and that all Californians have opportunities for economic prosperity.

The intended outcomes that represent Healthy Economy include:

- Reliable water supplies of suitable quality for a variety of productive water uses are based on a reliable supply;
- Consideration of economic risks and rewards on floodplains, rivers, and coastal areas;
- More benefits from economics activities;
- Reduced likelihood or occurrence of significant social disruption following a disaster.

1.4 Opportunities for Enriching Experiences

The vision for this societal value is that all Californians have opportunities for enriching experiences to add greater value or significance to their lives.

The intended outcomes that represent Opportunities for Enriching Experiences include:

- Preserved or enhanced culturally or historically significant sites and communities, including continued and enhanced access to water and land used for cultural practices, such as sacred ceremonies;
- Preserved and increased natural areas with aesthetic or intrinsic value (including view shed);
- Continued and enhanced access to resources that support education and learning;
- Continued or enhanced recreational opportunities in waterways, reservoirs, or natural and open spaces.

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2 Methodology

The methodology for developing the initial set of indicators for piloting at both the statewide and watershed scales is described below.

2.1 Statewide versus Watershed Scale

Indicators are the data and information that are used to measure what progress has been made in achieving the intended outcomes at a given point in time. California water management is complex and the underlying regions are diverse. Large volumes of data are already being collected throughout the state by local, regional, and State entities. Not all data are relevant to decision-making in all regions. Neither is it practical nor necessary to use all available data to assess water management sustainability. For these reasons, the Sustainability Outlook identifies a manageable set of indicators that apply statewide and can be used for conducting watershed-scale sustainability assessments.

Applied at the state level, indicators are intended to be broad and cover differing conditions (e.g., coastal and inland areas; north and south of, as well as in, the Delta). At a watershed level, indicators will measure what is relevant to a specific area, which may or may not be the same as what is relevant on a statewide basis (e.g., specific areas of the state where the majority of the population is not served by a public water system; or flood safety improvements in upper watersheds, which may differ from those in valleys). Indicators will likely change as the ability to collect and interpret data changes, the conditions in the state change, or the understanding of intended outcomes evolves.

2.2 Development of Preliminary Set of Indicators

A preliminary set of indicators was compiled from existing information, including:

- Update 2013
- 2014 California Water Action Plan and 2016 Update
- California's Flood Future: Recommendations for Managing the State's Flood Risk and other State Flood Management Planning Program materials
- 2012 Central Valley Flood Protection Plan and 2017 Update (draft)
- Disadvantaged Community Visioning Workshop
- Sustainable Groundwater Management Act (SGMA) Draft Strategic Plan
- Materials related to Integrated Regional Water Management strategies
- Water Sustainability Indicators Framework: Final Report (U.C. Davis 2013)
- California Integrated Assessment of Watershed Health (U.S. EPA 2013)
- Sustainable Water Management Profile (Water Foundation and Inland Empire Utilities Agency 2017)
- Other Companion State Plans

Additionally, requests to complete an online survey related to water management effectiveness were emailed to the Water Plan distribution list in early 2017. Results of this survey informed the preliminary indicator set. As there are multiple components to assessing progress towards achieving each intended outcome, there often several indicators for each outcome. And some indicators may apply to multiple outcomes (but are primarily associated with ONE outcome).

2.3 Testing and Revising the Indicators

Using the preliminary indicator set, California Water Plan (CWP) staff met with interested parties, California Department of Water Resources (DWR) subject matter experts, representatives from various State agencies and organizations, advisory groups, and stakeholders to obtain their input on and assessment of the general indicator framework, the preliminary list of indicators, availability and quality of data, and ways to acquire additional and/or better data and information. A listing of the indicator discussions held is presented in Table 2-1.

Table 2-1. Indicators Discussions Held to Support California Water Plan Update 2018¹

Agency/Organization	Date
DWR, Sustainable Groundwater Management Program	June 1, 2017; July 6, 2017
DWR, Economic Analysis Section	June 1, 2017
State Water Board, Surface Water Ambient Monitoring Program	June 2, 2017
DWR, Interstate Resources	June 6, 2017
DWR, Urban and Agricultural Water Use Efficiency Program	June 6, 2017
California Department of Parks and Recreation, Division of Boating and Waterways	June 12, 2017
California Department of Fish and Wildlife, Water Branch and State Wildlife Action Plan	June 13, 2017
DWR, Environmental Restoration and Enhancement Branch	June 13, 2017
DWR, Water Budget and Analytics Section	June 15, 2017
DWR, Legislative Affairs Office	June 15, 2017
DWR, Office of Tribal Advisor	June 19, 2017
DWR, Strategic Water Planning Branch	June 19, 2017
DWR, Integrated Water Management Program, Disadvantaged Communities	June 19, 2017
DWR, Division of Flood Management, Flood Planning Office	June 20, 2017
California Biodiversity Council, Interagency Alignment Team Workshop	June 22, 2017
California Water and Environment Modeling Forum	June 28, 2017
Water Foundation	July 17, 2017
Chapter 2 Workshop	July 25, 2017
California Department of Forestry and Fire Protection, Fire and Resource Assessment Program	September 20, 2017
California Water Plan Plenary	September 27, 2017
Russian River Pilot Working Sessions	November 15, 2017 December 11, 2017 April 23, 2018
Update 2018 – All Chapters Webathon	January 10, 2018
California Water Action Collaborative	February 5, 2018
California Water Plan Policy Advisory Committee	February 27, 2018

Note:

¹ As of February 6, 2018.

Key:

DWR = California Department of Water Resources

State Water Board = State Water Resources Control Board

Feedback was given in many forms – suggestions, questions, comments, and materials/hyperlinks. Feedback related to:

- Sustainability Outlook
 - Questions on development and use
 - Role of climate change
 - Reflecting evolving processes and issues
- Intended Outcomes
 - Reflecting sustainability for the specific societal value
 - Managing undesirable results
- Statewide versus Watershed Level
 - Aligning/reconciling implementation at various scales throughout the state
 - Connecting watershed-level efforts with statewide and vice versa
 - Defining watersheds and aligning/reconciling with other existing regional definitions
- Indicators
 - Suggestions and questions on revisions, additions, deletions, combinations, and movement to more appropriate outcomes
 - Consistent and clear terminology; specific definitions
 - Minimizing overlap among indicators
 - Illustrating the severity of an issue
 - Ability to reflect current status and impacts of current related actions
 - Appropriateness (indicators of aspects the State can affect versus those the State cannot control)
- Data
 - Potential existing and future data sources
 - Availability, accessibility, visibility, and alignment (or lack thereof)
 - Repeatability of collection and analysis to allow for comparison over time
 - Importance of consistent interpretation and trend analysis

- Need for long time periods to develop data useful for modeling purposes

The feedback received was used to refine, combine, and screen the indicators. Feedback was also used to inform updates of the intended outcomes and the overall development process. In this way, the indicators and Sustainability Outlook are better able to capture the existing and ongoing sustainability efforts of State government and improve both consistency and coordination amongst State agencies.

2.4 Potential Next Steps in Indicator Development

2.4.1 Pilot Programs

At present, DWR is conducting one pilot program in the Russian River watershed and developing another in the Santa Ana watershed. As anticipated, both pilots will use the current set of indicators to demonstrate how the Sustainability Outlook can be applied at the watershed scale. DWR is also working with the Water Foundation to incorporate lessons learned from its recently completed Sustainability Water Management Profile into both pilots. Current results of these pilots will be included in the final draft of Update 2018.

Russian River Watershed. The Russian River watershed was selected as a pilot area because of established relationships, as well as the innovative and participatory local entities with relatively few distinctive jurisdictions or agencies when compared to other watersheds in the state. Work will be performed in alignment with California Forward's and Sonoma County Water Agency's sustainability planning when developing a framework for defining sustainability outcomes and metrics, aligning regulatory processes to achieve sustainable outcomes, improving governance and implementation efficiency, and identifying funding and finance options and capacity across the four societal values. As planned, this pilot will apply the outcome-based planning concepts advanced by the Water Plan at a watershed scale. Additional work under this pilot will provide insight on policy development of watershed-based planning, regulation, governance, and funding and finance innovations.

Santa Ana Watershed Pilot. The Santa Ana River watershed was selected as a pilot area because of established relationships, as well as the innovative sustainability planning of the One Water One Watershed (OWOW) plans coordinated by the Santa Ana Watershed Project Authority (SAWPA). The OWOW 2.0 Plan (2014) created an indicators-based tool for assessing integrated regional water management plan performance, based on earlier DWR grant-supported work at the Council for Watershed Health and Update 2013 work at University of California, Davis. This pilot draws from the earlier work and the experience in the region with application of the Water Foundation's SWM Profile. The pilot results will further integrate and prove the value of using the Outlook as the basis for understanding progress toward stakeholder-developed watershed goals to serve regional decision-making.

2.4.2 Moving Forward to 2023 and Beyond

Subsequent results of the pilots will be used to test and refine the indicators and the overall Sustainability Outlook approach. DWR intends to work with regional water management groups and other partners to develop appropriately scaled, watershed-based Sustainability Outlooks. Planning at a watershed scale can help water managers evaluate and consider the interdependencies among physical, biological, economic, and social processes, from headwaters to outlets and between basins. It is anticipated that these Watershed Sustainability Outlooks will be included in Update 2023, to support statewide planning and inform State investment priorities. DWR recognizes that most of the work to advance sustainable water resources management will occur at regional and local levels.

Moving forward, additional data and tools will be developed and employed to strengthen the Sustainability Outlook approach, evaluate trends, and assess current and future water resources management sustainability.

Over time, indicators will likely continue to change as the ability to collect and interpret data changes, the underlying conditions in the state and watersheds change, or the understanding of intended outcomes evolves, both at the state and watershed levels.

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3 Screening Process

Each indicator went through a comprehensive screening process to reach the current recommendation of whether it should be archived, kept as a basic indicator, considered at the watershed level only, or advanced in the future. These levels are described in Figure 3-1.

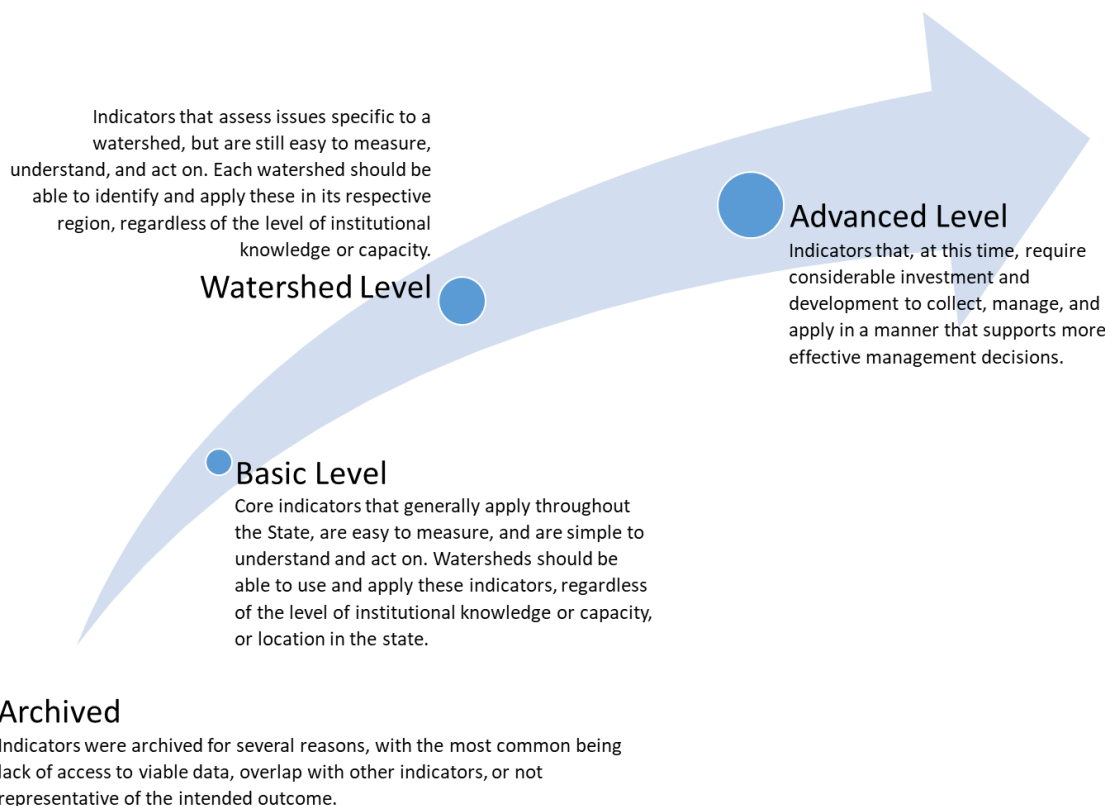


Figure 3-1. Description of Indicator Recommendations (Preliminary Graphic)

An indicator labeled as “future” does not have complete data available to support its application in all areas. This may be because the data have never been collected, or are not collected statewide or across all watersheds where such indicator would apply. An indicator labeled as “Advanced (Future)” is not only more complex (advanced) but data do not currently exist (future) to apply or test it at this time. An Advanced (Future) indicator could be highly effective but will take time and investment to fully develop and use throughout the state

3.1 Screening Criteria and Ranking

The following criteria were the primary basis for screening indicators and associated metrics:

- Representative
- Data Viability
- Cost

- Longevity
- Supportive of Decision Making

Each indicator was screened based on its ability to meet the primary criteria using a Low/Medium/High ranking system, as illustrated in Figure 3-2. In some cases, indicators were given a Medium-High ranking or a Low-Medium ranking.

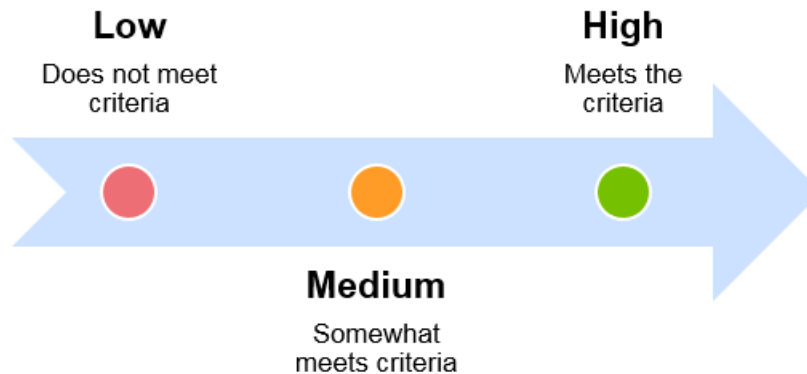


Figure 3-2. Indicator Criteria Rankings (Preliminary Graphic)

3.1.1 Representative

Whenever possible, indicators should directly measure their respective desired outcome(s). Characteristics of a representative indicator include:

- Designed to reflect on statewide and/or regional scale.
- Adaptable at regional and state levels.
- Informative in evaluating environmental/social/economic conditions, as well as the influences on these conditions.
- Reflective of an important aspect of the social, environmental, or economic pillars.
- Accurate correlation exists with the issue for which it is a proxy.
- Independent, in that it isn't related to or reliant on other indicators, to design an efficient indicator system. Since some critical indicators may be related and somewhat dependent on each other, independence is considered secondary to developing both easily-measured and representative indicators.

3.1.2 Data Viability

Characteristics of data viability in an indicator include:

- Data are collected to yield measures that are scientifically acceptable and support sound conclusions about the state of the system being studied.
- Data are available and accessible, accurate, comparable over time, complete with historical information, and cover sufficient geographic areas.
- Data collection is standardized.
- Data collection is (or can easily be) consolidated and performed by a single entity or small number of entities.
- Meaningful differences are distinguishable in environmental conditions with an acceptable degree of resolution.
- Data analysis reveals important changes in the factor of interest.
- Data analysis produces the same value if repeated in the same way on the same population at almost the same time.
- Data analysis is straightforward and results are quantifiable.

3.1.3 Cost

Indicator costs should be evaluated for the cost to collect and maintain the data needed. These costs should be manageable, in conjunction with an efficient process for analysis and reporting. At this time, cost is evaluated in relation to other indicators categorized in the same intended outcome.

3.1.4 Longevity

Indicators should be applicable in both short-term and long-term time frames for the ability to report on changes due to management actions. Characteristics of longevity in an indicator include:

- Available data set spans many years to allow for reporting on trends over time.
- Relatively quick response to management intervention. The ability to readily observe change over time (e.g., 2 – 3 years) may be preferable to and provide more efficient management than an indicator that requires a long period of time to detect similar changes (e.g., 20 + years). However, it is also important to recognize that many process take decades or longer to change or recover. Indicators for those projects and programs should be stable over these longer timeframes (decades).
- The range of natural variation can be quantified and accounted for in evaluations.
- Long-term relevance. Some sustainability goals may require long-term solutions, so those indicators should be applicable in the short-term but also intergenerational and usable over the long-term.
- Representative of large aspects of the intended outcome and trends, rather than narrowly focused.

- Provides information at both broad and fine spatial scales, as these indicators can help inform both strategic and site-specific decisions and be more useful.

3.1.5 Supportive of Decision Making

Indicators should measure the effects of management actions and clearly communicate information to various stakeholders for making policy decision on both regional and statewide scales. Characteristics of an indicator that is support of decision-making include:

- Provides information appropriate for making policy decisions.
- Relevant to actual or anticipated policies.
- May be used to evaluate the effects or effectiveness of management actions to meet state, or regional goals and objectives.
- Easily understood by those making different types of decisions (e.g., scientists, public, elected officials).
- Simple to understand and easy to communicate.

3.2 Classification of Indicators Based on Data Availability

Indicators meeting the above criteria were further evaluated as to whether data were available to be applied in the Sustainability Outlook, either at a statewide or watershed scale. This evaluation process is described below and shown in Figure 3-3.

- **Type I** – Adequate data were readily available and could be used to support the development of the indicator. These data were generated by ongoing, systematic monitoring or data collection efforts.
- **Type II** – Full or partial data generated by ongoing systematic and/or collection were available, but either a complete cycle of data had not been collected, was not geographically complete, or further data analysis or management was needed.
- **Type III** – Data were available from a single or limited effort providing a “snapshot in time,” or piecemeal data were available, but no ongoing monitoring or data collection was in place to provide data over an extended period. However, these data were useful in revealing gaps that may need to be filled.
- **Type IV** – The needed data have never been collected. Either:
 - The requirements to collect and monitor the data were well understood and collection and application to the Sustainability Outlook appeared feasible or
 - The requirements to collect and monitor the data were not well understood, cost-prohibitive, or the data would not be expandable on a temporal or spatial scale.

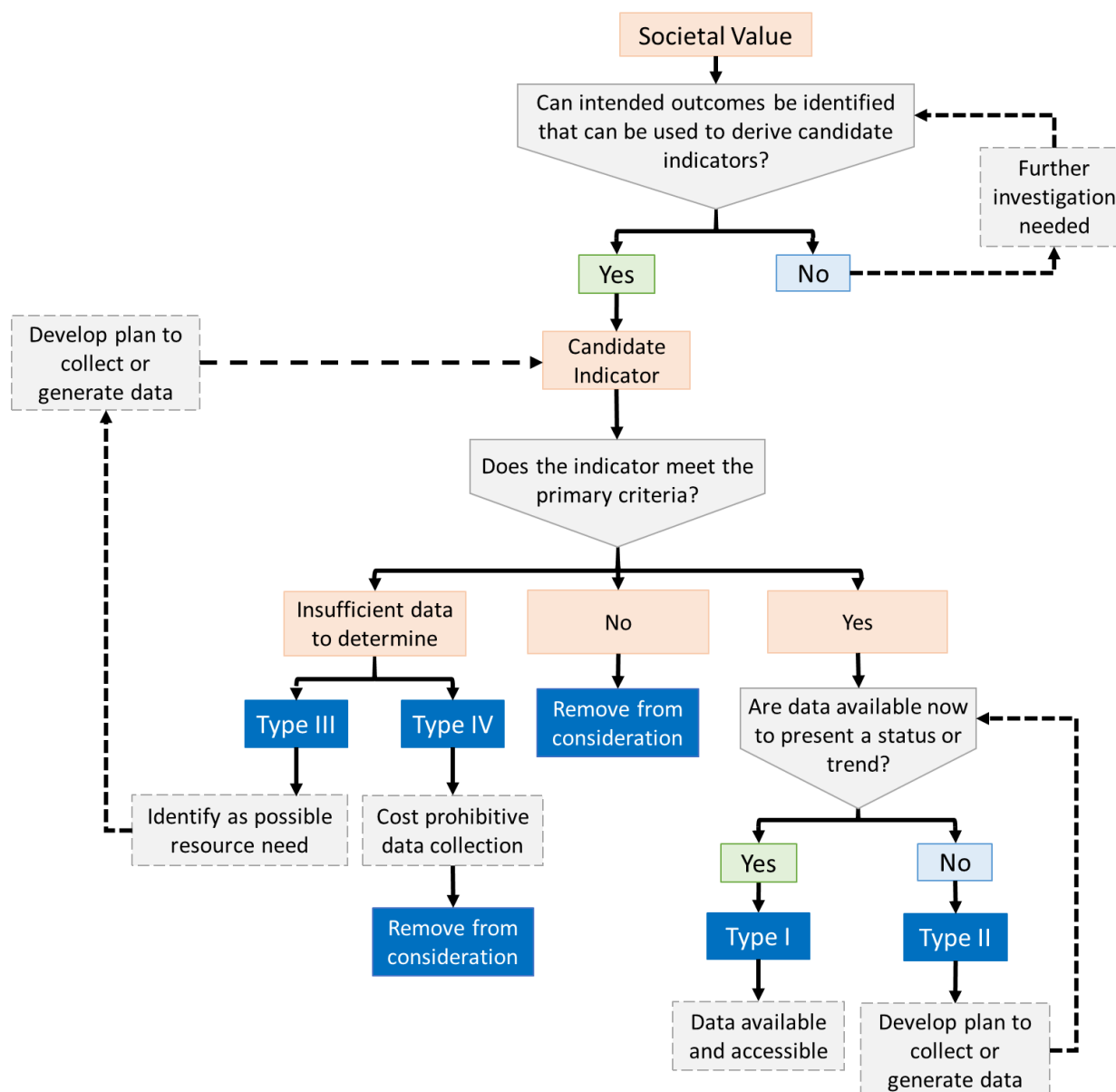


Figure 3-3. Flowchart of Process to Classify Indicators Based on Data Availability (Preliminary Graphic)

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4 Basic and Watershed Sustainability Indicators

This section describes each sustainability indicator that was considered Basic level (i.e., applicable statewide as well as at a watershed level) or Watershed level as a result of the screening process. Each indicator assessment provides a description of the indicator, its importance, insight on the screening process, recommendations, and any references utilized. In addition, the ideal target for the indicator is described.

The **current** list of indicators is shown in Table 4-1 and is subject to change as indicators are more fully developed. Indicators are grouped by societal value (Public Health and Safety, Ecosystem Vitality, Healthy Economy, and Opportunities for Enriching Experiences) and then further sorted by the corresponding intended outcome. In this table and throughout the document, Public Health and Safety is coded in red, Ecosystem Vitality in blue, Healthy Economy in green, and Opportunities for Enriching Experiences in yellow. Each intended outcome has several indicators. In some cases, while an indicator is presented under one corresponding outcome, it may provide insight into multiple outcomes.

The “ID” column provides a reference number for each indicator, which also includes its societal value, however the ordering does not denote importance or weighting. The “Data Type” classification is as described in Section 3.4 (above). The “Status” column represents how complete of an analysis has been conducted for an indicator. **Green** indicates that data were collected and mapped, and results could be used to analyze the indicator. **Yellow** indicates that some data were found and an initial analysis was attempted, but additional effort will be required to develop and further evaluate the indicator. **Orange** indicates that additional work will be necessary to define the indicator and/or potential data sources to allow for development and evaluation.

Where data sources, methodologies, or resulting information from indicators overlap, attempts to combine the indicators were, and will continue to be, made. Additional details can be found in the recommendations for each individual indicator.

Table 4-1. Comprehensive List of Intended Outcomes and Associated Basic and Watershed Indicators

















Societal Value	ID	Indicator	Level	Data Type	Status
Public Health and Safety	Intended Outcome – A reliable water supply for domestic needs, sanitation, and fire suppression.				
	PHS 1	Population and Percentage of Population with Reliable Domestic Water Supplies	Basic	Type II	
	PHS 2	Population and Percentage of Population without Access to Reliable Sanitation	Basic	Type II	
	Intended Outcome – Reduced number of people exposed to waterborne health threats such as contaminants or infectious agents.				
	PHS 3	Number of Public Water Systems Not in Compliance with Drinking Water Standards	Basic	Type I	
	PHS 4	Percentage of Beaches with Safe Coliform Bacteria Levels	Basic	Type III	
	PHS 5	Water Supplies Derived from 303(d) Impaired Water Bodies	Basic	Type I	
	PHS 6	Potential for Consumption of Mercury-Contaminated Fish	Basic	Type I	
	Intended Outcome – Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure)				
	PHS 7	Population Served by Local Hazard Mitigation Plans, Emergency Response Plans, or Equivalents	Basic	Type II	
	PHS 8	Population Covered by Water Shortage Contingency Plans	Basic	Type II	
	PHS 9	Urban Population without State-Mandated Urban Level of Flood Protection	Basic	Type II	
	PHS 10	Population in Floodplains with Equal to or Greater than a 1 Percent Chance of Flooding in any Given Year	Basic	Type III	
Ecosystem Vitality	Intended Outcome – Maintained and increased ecosystem and native species distributions in California while sustaining and enhancing species abundance and richness.				
	EV 1	Native Fish Diversity Index	Basic	Type I	
	EV 2	Non-Native Invasive Species Distribution and Status	Basic	Type I	
	Intended Outcome – Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.				
	EV 3	Acreage of Wetlands	Basic	Type I	
	EV 4	Degree of Aquatic Fragmentation	Basic	Type II	
	EV 5	Impaired Water Bodies – by Hydrologic Region	Watershed	Type I	
	EV 6	California Stream Condition Index	Basic	Type I	

Table 4-1. Comprehensive List of Intended Outcomes and Associated Basic and Watershed Indicators (contd.)























Societal Value	ID	Indicator	Level	Data Type	Status
Ecosystem Vitality (contd.)	Intended Outcome – Achieved designated beneficial uses for water bodies throughout the state.				
	EV 7	Impaired Water Bodies – Count by Watershed	Basic	Type I	
	EV 8	Number of Harmful Algae Blooms	Basic	Type I	
Healthy Economy	Intended Outcome – Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply.				
	HE 1	Delivery Reliability of SWP, CVP, and Colorado River Aqueduct Systems	Basic (Future)	Type I	
	HE 2	Comparison of Actual Water use to Proposed Statewide Water Use Targets	Basic (Future)	Type I	
	HE 3	Distribution System Leaks and Losses	Watershed	Type II	
	HE 4	Groundwater Basins with Stable or Recovering Groundwater Levels	Basic	Type I	
	HE 5	Groundwater Extraction Rates and Subsidence Rates	Basic (Future)	Type III	
	HE 6	Change in Groundwater Storage	Basic	Type III	
	HE 7	Percentage of Groundwater Basin Areas in Compliance with SGMA	Basic	Type III	
	HE 8	Contaminated Groundwater Wells	Basic	Type II	
	Intended Outcome – Consideration of economic risks and rewards on floodplains, rivers, and coastal areas.				
	HE 9	Socioeconomic Vulnerability to Sea Level Rise Impacts	Basic	Type I	
	HE 10	Areas Covered by Local Coastal Program Vulnerability Assessments Updated for Sea Level Rise	Basic	Type II	
	Intended Outcome – More benefits from economics activities, including from reduced costs to provide a given level of service (including transaction and permitting costs)				
	HE 11	Regional Trend in Cost of Water for Municipal and Industrial, Agricultural, and Other Purposes; Cost Compared to State Average for these Same Supplies	Watershed	Type II	
	HE 12	Volume of Water Transferred on the Open Market; Cost of Water on the Transfer Market	Basic	Type III	
	HE 13	Percent of Average Annual Power Demand Satisfied by Hydropower	Basic	Type I	

Table 4-1. Comprehensive List of Intended Outcomes and Associated Basic and Watershed Indicators (contd.)

Societal Value	ID	Indicator	Level	Data Type	Status
Healthy Economy (contd.)	Intended Outcome – Reduced likelihood or occurrence of significant social disruption following a disaster.				
	HE 14	Value of Assets within Floodplains with Equal to or Greater than a 1 Percent Chance of Flooding in any Given Year	Basic	Type I	
Opportunities for Enriching Experiences	Intended Outcome – Preserved or enhanced culturally or historically significant sites and communities, including continued and enhanced access to water and land used for sacred ceremonies or cultural practices.				
	OEE 1	Number of Historically and Culturally Significant Sites at Risk of Flooding or Sea Level Rise	Basic	Type II	
	Intended Outcome – Preserved and increased natural areas with aesthetic or intrinsic value (including view shed).				
	OEE 2	Change in Natural Area	Basic	Type I to Type III	
	Intended Outcome – Continued and enhanced access to resources that support education and learning.				
	OEE 3	Number of School Districts Using Water and Environmental Curriculum in K through 12 Programs	Basic	Type II	
	OEE 4	Number of Students Enrolled in Water and Environmental Resources Management Programs within the UC and CSU Systems	Basic	Type I	
	OEE 5	Number of Water Agencies that Have Educational Programs for Customers	Basic (Future)	Type II	
	Intended Outcome – Continued and enhanced recreational opportunities in waterways, reservoirs, or natural and open spaces				
	OEE 6	Change in Visitor Days at Water Related Park Lands	Basic	Type III	

Key:

CSU = California State University

CVP = Central Valley Project

EV = Ecosystem Vitality

HE = Healthy Economy

K = kindergarten

OEE = Opportunities for Enriching Experiences

PHS = Public Health and Safety

SGMA = Sustainable Groundwater Management Act

SWP = State Water Project

UC = University of California

Public Health and Safety

Intended Outcome: A reliable water supply for domestic needs, sanitation, and fire suppression.

PHS 1: Population and Percentage of Population with Reliable Domestic Water Supplies

This indicator analyzes the level of access to reliable domestic water supplies. For this indicator, access to reliable domestic water supply is defined as the ability to meet (1) water demands consistently across the full range of climatic conditions, and (2) acceptable service standards during catastrophic conditions. A reliable water supply should be of suitable quantity and quality for its purpose.

The target outcome for this indicator is 100 percent of the population having access to reliable domestic water supplies.

Scale:	Statewide
Data Sources:	Urban Water Management Plans (UWMP); State Water Resources Control Board (State Water Board) Division of Drinking Water (DDW); CWP Update 2013; U.S. Department of Health and Human Services, Indian Health Service (IHS)
Data Availability:	Type II
Metric:	Percent of population
Screening Status:	Basic

Importance and Screening Considerations

Populations in municipalities and counties should readily have access to clean and sufficient domestic water supplies to meet public health and safety standards. Lack of access to reliable domestic water supplies to meet basic domestic needs can be attributed to a variety of underlying conditions, including drought, poor water quality, affordability, insufficient infrastructure, and others. As California continues to face conditions that may affect access to reliable domestic water supplies, assessing the State's progress towards reducing those effects will continue to be an important indicator of public health and safety.

Through the screening process, this indicator was categorized as a Basic level indicator. This indicator was found to be highly representative of its target outcome of a reliable water supply at both a statewide and watershed scale. This indicator may help decision makers determine areas where segments of the population do not have access to reliable domestic water supplies.

Partial data are available on water quantity and water quality, through different databases. Centralized data on the reliable quantity of water available are collected through UWMPs that are updated every five years. A methodology to determine the number of Californians without access to safe water and sanitation was developed as part of Update 2013 process in the *Californians without Safe Water and Sanitation* report. Two different portions of this methodology are applicable to this indicator and to *PHS 2, Population and Percentage of Population without Access to Reliable Sanitation*, respectively. The portion applicable to this indicator uses water quality information to determine if a water system provides safe water, where water quality data are available, such as through the DDW.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

An initial analysis on the reliability of water supplies, focusing on available quantity of water, for urban systems was conducted using data collected through the UWMP process via DWR's Water Use Efficiency Data portal. These data include the population served by each urban water supplier as well as supply and demand in normal years and consecutive dry years. Table 4-2 presents the population and the percent of total California population served by each wholesale or retail urban water supplier that is projected to meet, in 2020, at least 100 percent of normal year demands with their supplies and 80 percent of demand with their supplies during the course of a three-year drought. These data come from the 2015 UWMPs. Per legislation, UWMP documents project out in 5-year increments to 20 years, of as far out as data are available. UWMP multi-year drought projections occur at the first five-year increment. Some overlap may exist in the populations served by wholesale and retail water suppliers. Not all the information shown in Table 4-2, submitted by urban water suppliers, has been reviewed by DWR as part of the UWMP review process.

Table 4-2. Population Served by Urban Water Retailers Able to Meet Demands in Normal and Multi-Year Drought Conditions in Year 2020

	Population Served	Percent of 2020 California Population Projection (40,719,999)
Retail Urban Water Supplier		
Demands Met	27,465,009	67.4%
Demands Unmet	1,509,733	3.7%
Total	28,974,742	71.2%
Wholesale Urban Water Supplier		
Demands Met	3,522,584	8.7%
Demands Unmet	717,554	1.8%
Total	4,240,138	10.4%

Sources: *Water Use Efficiency Data Public Portal. January 10, 2018.*
California Department of Finance. January 10, 2018.

As shown in Table 4-2, at least 3.7 percent of the California population is served by urban water retailers that cannot adequately meet demands based on quantity of water using their current and/or projected supplies. These data cover between 71.2 percent and 81.6 percent of California's population. (The amount of overlap between populations served by retail urban water suppliers and wholesale urban water suppliers is not addressed.)

The *Californians without Safe Water and Sanitation* report provides a separate methodology to establish the number of Californians without safe drinking water. The report focuses primarily on water quality, whereas the UWMP process focuses primarily on water quantity. The report examines available data by the type of water system that supplies drinking water to each home and splits these into five categories: private domestic well, local small water system, state small water system, tribal water system, and community water system. Table 4-3 displays the available data and data sources used in Update 2013.

Some data have been updated from this report, as noted in the table. For some systems, data are available on the population served and the quality of water provided. However, major data gaps remain.

Table 4-3. Estimate of Californians Without Safe Drinking Water

Type of System (No. of Service Connections)	Total No. of Systems	Total Population Served	No. of Systems Without Safe Water	Population Served Without Safe Water	Percent of Population Served Without Safe Water
Private Domestic Well (1)	200,000 – 600,000 ¹	600,000 – 2,000,000 ¹	Data Not Available	Data Not Available	Data Not Available
Local Small Water System (2 – 4)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
State Small Water System (5 – 14)	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
Tribal Water System ²	(41,923 homes)	138,346	(1,574 homes)	5,195	3.7%
Community Water System (> 15) ³	2,905	41,695,950	246	377,515	0.9%

Source: Adapted from the *Californians Without Safe Water and Sanitation* report (Alarcon, Jose et al. 2014) and updated as indicated.

Notes:

¹ State Water Board, 2013, *Communities that Rely on a Contaminated Groundwater Source for Drinking Water*

² Approximately 160 tribal water systems are recognized by the U.S. Environmental Protection Agency in California, although this number does not include federally non-recognized tribes or small systems supplying less than 14 homes. No population estimates are available for these tribal water systems. Information on the number of homes is available through the Indian Health Service's Sanitation Tracking and Reporting System. This system documents information about sanitation deficiencies related to American Indian and Alaskan Native individual homes and communities. The total number of homes and number of homes without safe water include the number of homes with an Indian Health Service Deficiency Level of 3, 4, or 5 due to water-related issues as of December 15, 2017. The population estimates assume 3.3 persons per home.

³ Information on community water systems available through the Human Right to Water Portal. The number of systems out of compliance assumed to be the number of systems without safe water. Populations are as reported by the community water systems, which may include transients in addition to residents. Updated March 13, 2018.

As shown in Table 4-3, major data gaps exist to evaluate the populations with and without reliable domestic water supplies. Small systems of under 15 connections, and not covered under the IHS, are not monitored under State regulations. Generally, these systems lack adequate infrastructure and the economies of scale of larger systems, and may be more vulnerable to water quality issues than larger systems. However, data on small systems are not currently available. Local and state small water systems are not regulated by the State. California does not require sampling of private wells after installation, so individual owners may or may not conduct water quality testing. Groundwater Ambient Monitoring and Assessment's (GAMA) Domestic Well Project helps bridge the gap in information between public and private wells, but continued progress is impeded by a lack of funding.

Of note, tribal communities face a much higher percentage of populations without safe drinking water than communities served by community water systems. The 1988 amendments to the Indian Health Care Improvement Act (IHCA) require the IHS to maintain inventories of sanitation deficiencies for new and

existing American Indian and Alaskan Native homes and communities. Many American Indian and Alaskan Native tribes cooperate closely with the IHS' Sanitation Facility Construction Program, which works to directly prevent the spread of disease through construction of facilities to provide safe drinking water and waste disposal. This program also helps American Indian and Alaskan Native communities build the administrative and technical capabilities to construct their own sanitation facilities with engineering support from IHS. Although these programs result in projects to improve deficiencies for American Indian and Alaskan Native homes and communities, additional work is required to provide all individuals with safe reliable water supplies.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. A method to gather additional data for smaller water systems should be developed to obtain a complete and comprehensive statewide dataset. Similarly, the largest data gaps in analyzing water quality occur for small water systems and individual well owners.

UWMPs apply only to “urban water suppliers,” defined as “a water supplier, either publicly or privately owned, that directly provides potable municipal water to more than 3,000 end users or that supplies more than 3,000 acre-feet of potable water annually at retail for municipal purposes,” so smaller water systems are not represented in this data set. Data collected through UWMPs are readily available, but additional data should be gathered for non-urban water systems using similar methods to those presented in the UWMPs. In addition, information on the locations of the urban water retailers should be identified to provide a spatial representation of where populations without access to reliable domestic water supplies are located.

Water supply reliability may be an issue of water quality and/or water quantity depending on the region. Currently, data on water quality and water quantity would be difficult to reconcile into a single geocoded dataset for analysis to understand regional trends in water reliability. Assessing reliability may also involve tracking the percentage of imported supplies to regions.

In 2018, the California State Legislature (Legislature) enacted two policy bills – Senate Bill (SB) 606 and Assembly Bill (AB) 1668 – to establish both the foundation and needed authorities for long-term improvements in water conservation and drought planning to adapt to climate change and the resulting longer and more intense droughts in California. These bills amended the California Water Code, requiring state agencies to develop statewide water use targets, standards, and guidelines, and water agencies to then report on progress towards meeting those requirements. During the implementation process, DWR and other State agencies will further develop data, information, guidelines, and other technical assistance to help realize the bills’ intended outcomes. Both bills include requirements for public access to data and their use, as well as related studies, reports, and investigations. These data, studies, reports, and investigations may be of use to continued development of this indicator.

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Public Health and Safety

Intended Outcome: A reliable water supply for domestic needs, sanitation, and fire suppression.

PHS 2: Population and Percentage of Population without Access to Reliable Sanitation

This indicator assesses the percentage of California population that does not have access to adequate sanitation. While adequate sanitation is partly achieved through proper treatment and handling of wastewater, sanitation can also be interpreted on a larger scale of domestic needs such as sanitary water for cooking, bathing, and washing. For this indicator, access to reliable sanitation is defined as the ability to provide water of adequate supply and quality for domestic purposes.

The target outcome for this indicator is 100 percent of the population has access to reliable sanitation.

Scale:	Statewide
Data Sources:	CWP Update 2013; IHS; State Water Board
Data Availability:	Type II
Metric:	Percent of Population
Screening Status:	Basic

Importance and Screening Considerations

Treatment and handling of wastewater is an important factor in maintaining public health and safety, protecting the environment, and sustainably managing the state's water resources. However, some California residents live in communities or areas that do not have access to adequate, reliable sanitation.

During the screening process, this indicator was categorized as a Basic level indicator. This indicator is closely tied to providing a reliable water supply for domestic needs, its intended outcome. This indicator has statewide applicability. However, significant data gaps exist. Collecting information on sanitation is particularly difficult in rural areas, where sanitation services are not consolidated or provided by a public entity. In addition, merging data from public and private entities may have substantial costs and require significant effort. A methodology to determine the number of Californians without access to reliable sanitation was developed as part of the Update 2013 process in the *Californians without Safe Water and Sanitation* report.

Representative of Outcome:	High
Data Viability:	Medium-High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Within past analysis of the number of Californians without adequate sanitation in the *Californians without Safe Water and Sanitation* report, wastewater systems were grouped into the following three categories: onsite wastewater treatment system or septic system, tribal wastewater system, and centralized waste water treatment system with sewer collection. Only data on tribal wastewater systems are currently

available. The 1988 amendments to the IHCIA require the IHS to maintain inventories of sanitation deficiencies for new and existing American Indian and Alaskan Native homes and communities, including those related to sewer and solid waste. Table 4-4 summarizes existing data and data gaps.

Table 4-4. Estimate of Californians Without Adequate Sanitation

Type of System	Total No. of Systems	Total Population	No. of Systems Without Adequate Sanitation	Population Served Without Adequate Sanitation	Percent of Population Served Without Adequate Sanitation
Onsite Wastewater Treatment System (Septic System) ¹	1,200,000	>3,960,000	Data Not Available	Data Not Available	Data Not Available
Tribal Wastewater System ²	(41,923 homes)	138,346	(2,166 homes)	7,148	5.2%
Small Wastewater System	577 ³	Data Not Available	Data Not Available	Data Not Available	Data Not Available
Medium & Large Wastewater System	317 ³	Data Not Available	Data Not Available	Data Not Available	Data Not Available

Source: Adapted from the *Californians Without Safe Water and Sanitation* report (Alarcon, Jose et al. 2014) and updated as indicated.

Notes:

¹ Estimate from State Water Board's 2012 Onsite Wastewater Treatment System policy. The population estimate assumes that all 1.2 million septic systems are for residential use and assumes 3.3 persons per household.

² Information on the number of homes is available through the Indian Health Service's Sanitation Tracking and Reporting System. This system documents information about sanitation deficiencies related to American Indian and Alaskan Native individual homes and communities. The total number of homes and number of homes without adequate sanitation include the number of homes with an IHS Deficiency Level of 3, 4, or 5 due to sewer or solid waste-related issues as of December 15, 2017. The population estimates assume 3.3 persons per home.

³ Information from State Water Board's Integrated Water Quality System (CIWQS) database, as of 2014. Since population data are not available in CIWQS, the number of small water systems was estimated by determining the number of systems with a permitted flow of less than 1 million gallons per day (MGD), and the number of medium and large systems was estimated by determining the number of systems with a permitted flow of more than 1 MGD.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. Data availability and gaps are a major issue across the state, especially in rural and small communities. To assess this indicator, data must be collected for all non-tribal wastewater systems, including on the total number of these systems, the residential populations served, and the adequacy of the systems. State, regional, and local governments should coordinate to estimate the statewide total population without reliable sanitation. In addition, data should incorporate spatial information to analyze regional trends in the availability of sanitation.

References

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Public Health and Safety

Intended Outcome: Reduce number of people exposed to waterborne health threats such as contaminants or infectious agents

PHS 3: Number of Public Water Systems Not in Compliance with Drinking Water Standards

This indicator assesses the number of public water systems, and the populations served by those systems, not in compliance with drinking water standards. A positive outcome for this indicator is a decreasing trend in the number of public water systems not in compliance with drinking water standards. The target outcome for this indicator is no public water systems are out of compliance with drinking water standards.

The State Water Board DDW regulates public water systems in California. The DDW collects data on compliance with the drinking water regulations included in the California Code of Regulations, including violations by public water systems. Public water systems are defined as systems that serve 25 people a day at least 60 days a year or systems with at least 15 service connections. These public water systems must comply with established drinking water monitoring regulations. Drinking water standards are called maximum contaminant levels (MCL).

Scale:	Statewide
Data Sources:	State Water Board DDW
Data Availability:	Type I
Metric:	Population served by public water systems and number of MCL violations by public water systems
Screening Status:	Basic

Importance and Screening Considerations

More than 98 percent of Californians served by public water systems receive drinking water that meets federal and State drinking water standards. Threats to safe drinking water supply are numerous, many of which may be naturally occurring in addition to those resulting from human activities of industrial, agricultural, or urban origin. In addition, of over 7,500 public water systems in the state, the majority (about 87 percent) serve small communities of 1,500 people or less. Many of these small water systems are challenged by the lack of technical, managerial, and financial capacity, and many do not serve drinking water that meets current standards.

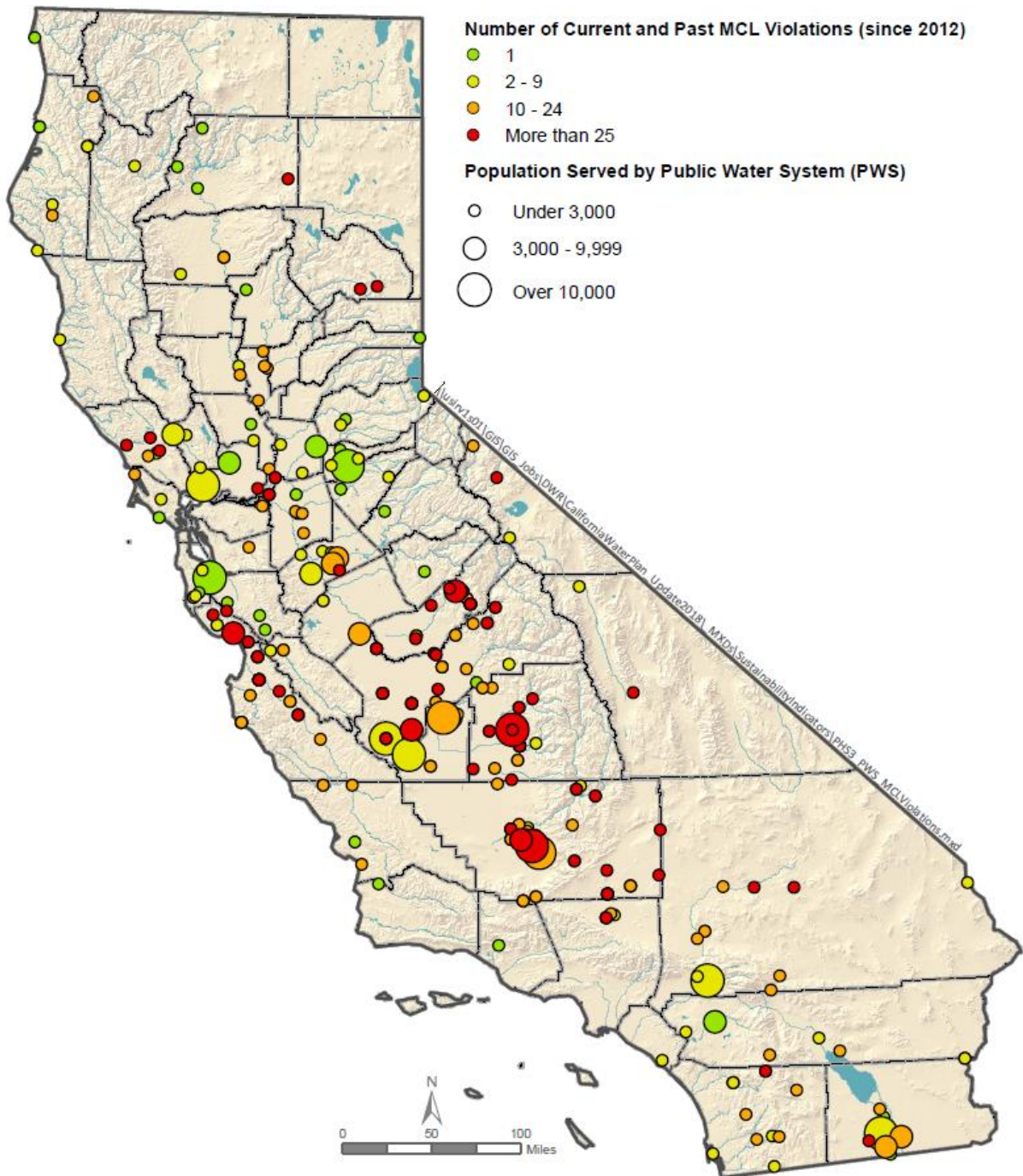
This indicator is categorized as a Basic level indicator. Data are available on MCL violations by public water systems through the DDW, but not those of smaller systems. In addition, water quality is an important component of providing a reliable water supply for domestic needs and sanitation.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Medium-High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Data from the State Water Board Safe Drinking Water Information System were used to determine the population and number of MCL violations for each public water system since 2012 for systems still out of compliance. Each water system has a unique identification number that the State Water Board uses to track the different violation category codes (e.g., MCL violations).

These data were mapped based on the counties and mailing addresses of the public water systems. As shown in Figure 4-1, the public water systems with the highest number of MCL violations are small systems that may lack technical, managerial, and financial capability to address those violations and their underlying causes. In addition, public water systems in the Central Valley have both more MCL violations and systems not in compliance with the MCLs compared to California as a whole. Currently, this indicator can only capture MCL violations from systems that follow regular monitoring and reporting requirements.



Source: Human Right to Water Portal. State Water Board. January 18, 2018

Figure 4-1. Public Water System Maximum Contaminant Level Violations

Recommendations

This indicator is a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

Potential future developments include:

- Analyzing five years of data instead of a single year.
- Gathering data from water systems too small to qualify as public water systems (under 25 people a day for 60 days or under 15 service connections) for a more representative statewide dataset.
- Analyzing the change in the location and quantity of violations with time or funding.

High importance should be placed on gathering data from small water systems. These systems are typically associated with communities that do not serve drinking water that meets current standards, but are challenged by lack of technical, managerial, and financial capacity to address violations and underlying causes.

References

State Water Resources Control Board. 2015. Safe Drinking Water Plan for California. Viewed online at: https://www.waterboards.ca.gov/publications_forms/publications/legislative/docs/2015/sdwp.pdf

California Urban Water Agencies. 2017. Tackling California's Water Accessibility and Affordability Issues. Viewed online at: http://www.cuwa.org/pubs/2017_CUWA-Water-Affordability-Fact-Sheet.PDF

State Water Resources Control Board. "Human Right to Water Portal." State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/hr2w/index.html. Last accessed: January 29, 2018.

Public Health and Safety

Intended Outcome: Reduce number of people exposed to waterborne health threats such as contaminants or infectious agents

PHS 4: **Percentage of Beaches with Safe Coliform Bacteria Levels**

This indicator assesses the percentage of beaches by county that receive A+, A, or B grades during wet weather monitoring, as analyzed in Heal The Bay's beach report cards. Beach advisories and beach closures occur when water quality testing finds high concentrations of contaminants exceeding health standards. Bacterial testing results are collected by Heal the Bay and reported through their beach report card process using standard grades.

A positive outcome of this sustainability indicator would be to have 100 percent of beaches to have safe coliform bacteria levels during wet weather monitoring.

Scale:	Statewide
Data Sources:	Heal the Bay Ocean Beach Report Card; State Water Board Beach Watch; County Health Departments; California Water Quality Monitoring Council's Safe to Swim Portal
Data Availability:	Type III
Metric:	Percentage of beaches with safe coliform bacteria levels during wet weather monitoring, as shown in Heal the Bay's beach report card
Screening Status:	Basic

Importance and Screening Considerations

Public exposure to harmful bacteria is a direct threat on public health and safety. Regular reporting of bacterial monitoring results at beaches, leading to contact exposure warning when necessary, can protect the public from water borne illnesses and other hazards associated with poor water quality as represented by high bacteria levels.

County health agencies monitor coastal beaches and issue warnings when water quality has contaminants that exceed health standards issued by the California Department of Public Health. The State Water Board provides BeachWatch, which is a non-public database of beach closures. Currently, no statewide water contact recreation standards exist for freshwater streams and lakes, although adoption of statewide bacteria water quality standards across freshwater and coastal waters is scheduled for early 2018.

This indicator is considered Basic level. Data provided to the State Water Board by local county health agencies of coastal counties are used by Heal the Bay to develop grades for beaches along California's coast. These data are inconsistent with respect to time. For example, water quality data at some beaches are collected on a weekly basis, while similar data at another beach data may only be collected after certain precipitation events. However, results are easily understood for decision making.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Medium-High
Potential Longevity:	Medium
Supportive of Decision Making:	Medium-High

Initial Data and Results

Heal the Bay rates beaches along the California coast and provides weekly and annual grades for certain grade periods. Grades are based off a point-based scoring system based on taking away points for exceedance of *Enterococcus*, Fecal Coliform, and Total Coliform indicators during monitoring. The most recent annual data, from April 1st, 2016 to March 31st, 2017 were used to develop Figure 4-2.

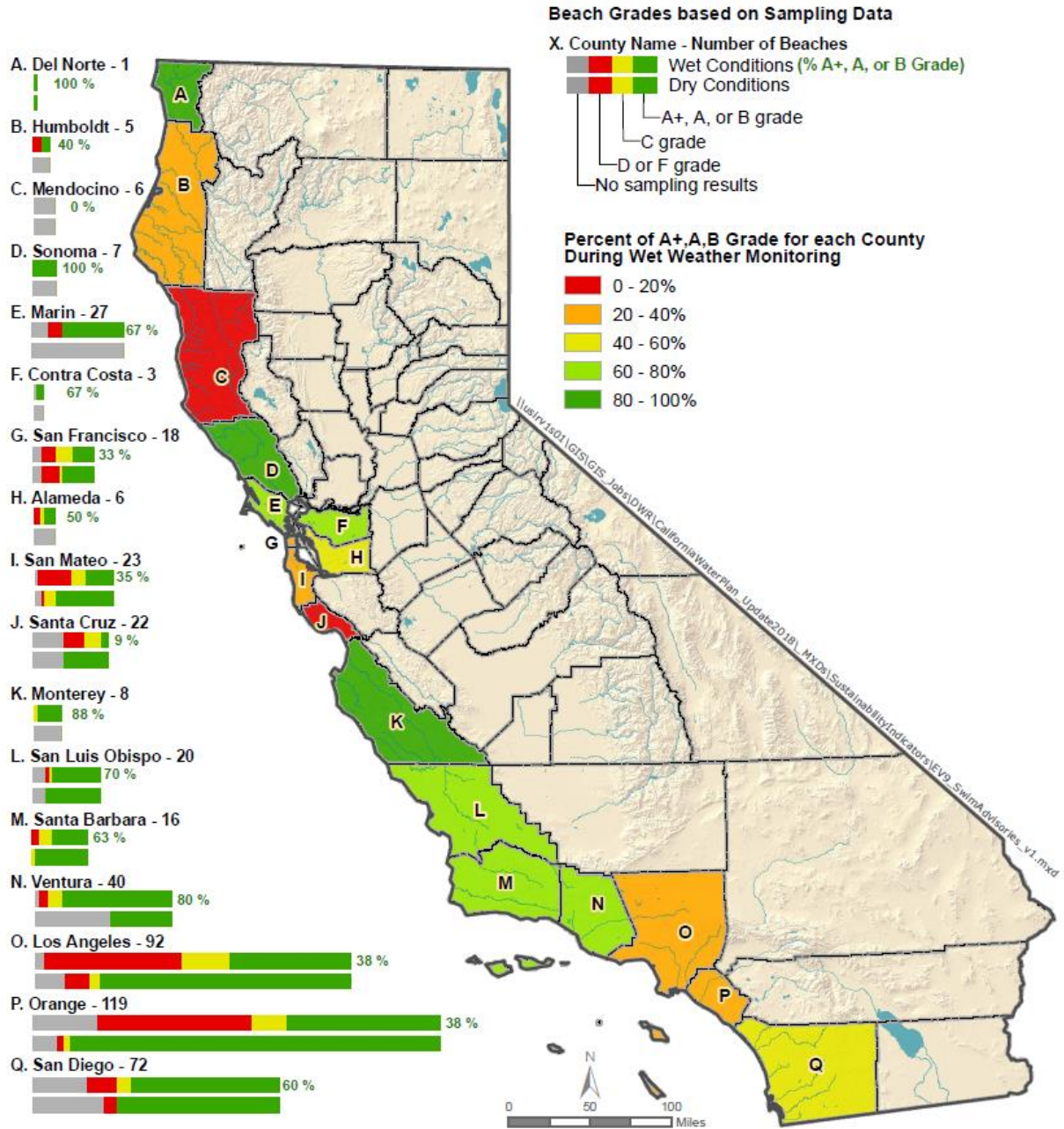
Data shown corresponds to:

1. wet weather conditions, days experiencing a rain event or over the following three days, and
2. dry weather conditions, days with no rain and at least three days after a rain event.

Wet weather conditions are often worse than dry weather conditions due to the impact of storm drain runoff, which flows untreated to the coast and can contain motor oil, animal waste, pesticides, yard waste, and trash. Although this indicator focuses on wet weather conditions, dry weather conditions data is shown to emphasize how these issues impact Californian beaches.

As shown in Figure 4-2, beaches in more urbanized counties face more water quality issues, especially in wet weather conditions. This is especially true for Los Angeles and Orange counties. In addition, dry condition sampling is not conducted at all the beaches presented by Heal the Bay. Expanding sampling programs may provide additional data, which could be used to post swim advisories as necessary to protect public health and safety, rather than only sampling after wet weather. Only two counties have data on all their beaches both in wet and dry conditions.

The Central Coast has the highest percentage of beaches, which during wet weather, have safe coliform bacteria levels.



Source: "Beach Grade." Heal the Bay. February 2, 2018.

Figure 4-2. Beach Grades Reported by Heal the Bay for California Beaches Representing Safe Coliform Bacteria Levels

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. The beach grades provided by Heal the Bay clearly show areas struggling to maintain safe levels of bacteria at monitored beaches. These areas can cause impacts to public health and safety and may be areas experiencing poor ecosystem health as well.

The State Water Board Beach Watch database may have additional data on beach closures that could be incorporated into this indicator, rather than using only Heal the Bay records. Although the number of beach advisories could provide information related to public health and safety, beach advisories are directly related to the number of rain events that occur at any given beach, more than the results of the water quality monitoring.

Currently, data are only available for coastal beaches. Few counties report freshwater swim advisories or closures electronically. Additional data gathering efforts would be required to centralize data on freshwater swim advisories, closures, and bacterial monitoring.

This indicator should eventually reflect changes made to statewide bacterial objectives, which are pending adoption by the State Water Board as of May 2018.

References

Heal the Bay. "Beach Grades." Beach Report Card. Viewed online at:
<http://brc.healthebay.org/?st=CA&f=1>. Last accessed: February 2, 2018.

Heal the Bay. 2017. Heal the Bay's 2016-17 Annual Beach Report Card.

California Water Quality Monitoring Council. "Is it safe to swim in our waters?" My Water Quality. Viewed online at: http://www.mywaterquality.ca.gov/safe_to_swim/index.html. Last accessed: February 2, 2018.

Public Health and Safety

Intended Outcome: Reduce number of people exposed to waterborne health threats such as contaminants or infectious agents

PHS 5: Water Supplies Derived From 303(d) Impaired Water Bodies

This indicator assesses the amount of water supply in gallons per day that is derived from 303(d) water bodies in California that are impaired for human health uses. A positive outcome for this indicator is a decreasing trend in the amount of water supply derived from 303(d) impaired water bodies. A target outcome for this indicator is zero water supplies derived from 303(d) impaired water bodies, which could also indicate a decrease in the amount of impaired water bodies statewide.

As required by the Federal Clean Water Act, the Clean Water Act Section 303(d) List of impaired water bodies is reassessed biennially by the State and Regional Water Boards. The Clean Water Act Section 303(d) List identifies impaired and threatened water bodies along with their pollutants. These water bodies do not meet Federal water quality standards.

Scale:	Statewide
Data Sources:	State Water Board eWRIMS database; State Water Board 2014/2016 California Integrated Report (Clean Water Act Section 303(d) List / 305 (b) Report)
Data Availability:	Type I
Metric:	Water supply volume
Screening Status:	Basic

Importance and Screening Considerations

Water supplies derived from 303(d) impaired water bodies may contain higher levels of constituents than water supplied derived from non-impaired water bodies. However, with proper treatment, water from impaired water bodies can still provide a safe water supply for beneficial use.

This indicator is considered a Basic level indicator. Assessing the amount of water supply derived from 303(d) impaired water bodies may be a direct indicator for the number of people who may be exposed to waterborne health threats such as contaminants or infectious agents. The Clean Water Act Section 303(d) List of impaired water bodies is easily accessible and well maintained by the State Water Board and local agencies. In addition, the State Water Board also collects data on points of diversion from surface water sources throughout California, including the amount diverted and stored, for permitting purposes.

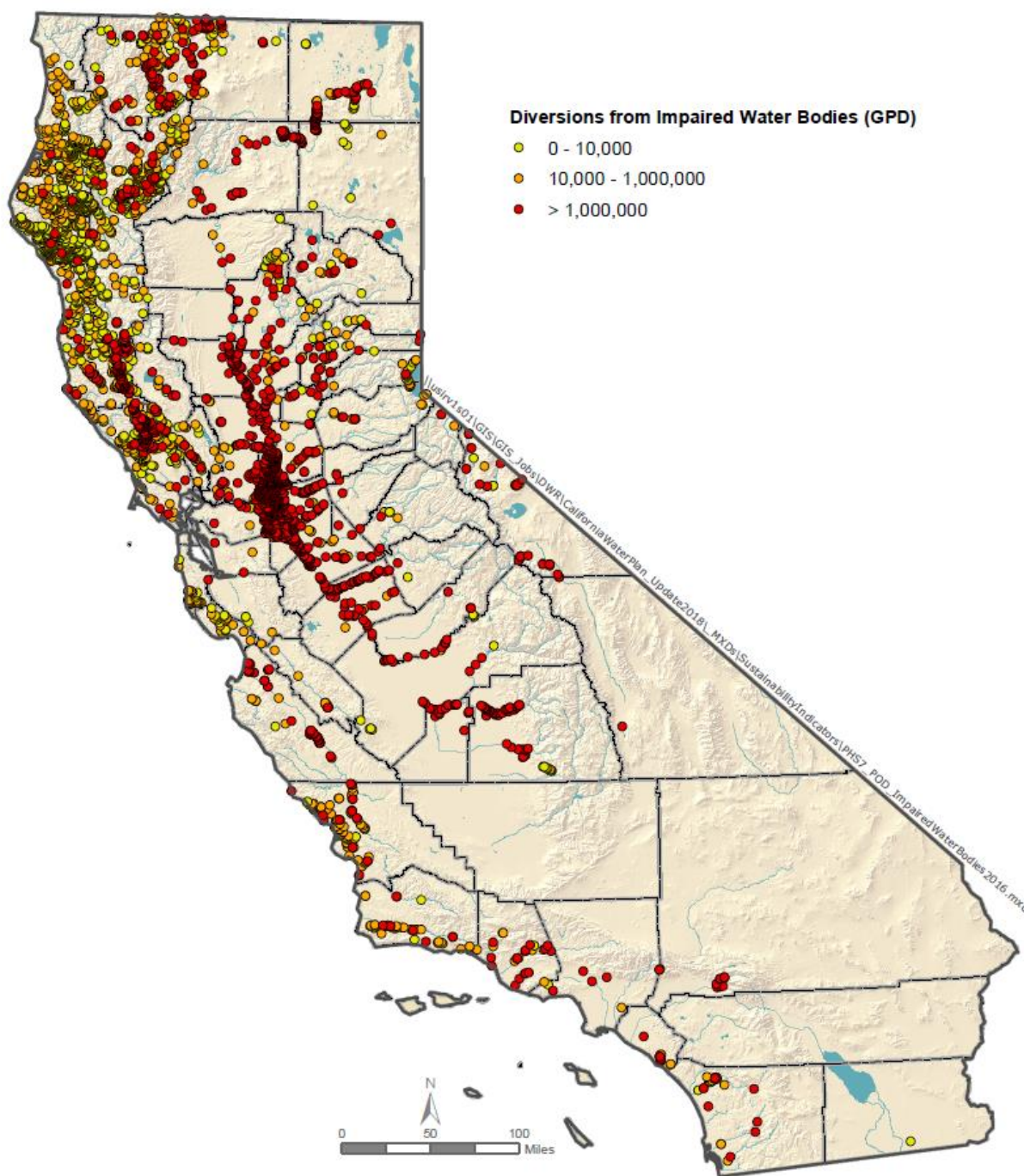
Representative of Outcome:	High
Data Viability:	High
Cost:	High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Data on claimed points of diversion throughout California and the amount of direct diversion of each point were pulled from the State Water Board website. In addition, the Geographic Information System (GIS) data for the 2012 list of 303(d) water bodies were used to identify which diversion points were within 400 meters of a listed location. This list represents the current listing, although updates from 2014 are undergoing approval.

Figure 4-3 presents points of diversion that are near impaired water bodies, corresponding to a GIS spatial analysis. The volume of water diverted in gallons per day is also shown. These data represent permitted diversions and not the true volume diverted on a daily basis. In addition, some of these diversions do not result in consumptive use of the water diverted.

However, this map can show areas of the state where the density of diversions from impaired water bodies is higher and closer analysis may be warranted. For instance, along the northern California coast, high quantities of water are diverted from impaired water bodies. This may be a result of a high density of impaired water bodies in the region. In addition, large diversions are also concentrated along the main water bodies in the Central Valley. These areas could be analyzed during planning to note if diversions from these impaired water bodies might directly impact public health and safety.



Sources: "Impaired Water Bodies – 2014/2016 Integrated Report Approval Documents." State Water Resources Control Board. April 11, 2018.

"eWRIMS - Electronic Water Rights Information Management System." State Water Resources Control Board. January 29, 2018.

Figure 4-3. Points of Diversion Permits from Impaired Water Bodies

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

A partial database of surface water diversions is maintained by the State Water Board. Currently, there is a lack of a centralized database containing data on surface water drawn specifically for drinking water use. In addition, the current GIS files provided for the impaired water bodies do not allow non-manual filtering of water bodies by their impaired purpose(s). Therefore, some of the impairments considered may not impact the final use of the diverted water. Many of the diversions are used for energy or stock watering, which may not require an unimpaired source of water.

The current methodology can highlight areas of the state where additional analysis, that could consider the final use of diverted water, may be necessary. The indicator may also need to be redefined to limit the diversions considered from all water supplies to those water supplies that require an unimpaired source of water.

References

State Water Resources Control Board. 2014/2016 Integrated Report Approval Documents.” State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml. Last accessed: April 11, 2018.

State Water Resources Control Board. “eWRIMS - Electronic Water Rights Information Management System.” State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/. Last accessed: January 23, 2018.

U.S. Environmental Protection Agency. “Clean Water Act Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs).” U.S.EPA. Viewed online at: <https://www.epa.gov/tmdl>. Last accessed: November 28, 2017.

Public Health and Safety

Intended Outcome: Reduce number of people exposed to waterborne health threats such as contaminants or infectious agents

PHS 6: Potential for Consumption of Mercury-Contaminated Fish

This indicator assesses the potential for consumption of mercury-contaminated fish by evaluating the concentration of mercury or other contaminants found in fish consumed by humans throughout the state. The target outcome for this indicator is that no potential for the consumption of contaminated fish exists throughout the state.

In addition, this indicator helps assess progress towards meeting statewide mercury objectives pertaining to tribal traditional and cultural use, including tribal subsistence fishing. The State Water Board and nine Regional Water Boards have regulatory authority to protect the water quality and beneficial uses of the state's waters. On May 2, 2016, the State Water Board adopted Resolution 2017-0027, providing a consistent regulatory approach throughout the state by setting mercury limits to protect beneficial uses associated with the consumption of fish by both people and wildlife. Three new beneficial use definitions have been established for future beneficial use designations including Tribal Traditional Culture, Tribal Subsistence Fishing, and Subsistence Fishing.

Although the State Water Board recently defined beneficial uses pertaining to tribal/traditional and cultural use, the provision does not require Regional Water Boards to designate specific waters in their regions with Tribal Traditional Culture, Tribal Subsistence Fishing, and Subsistence Fishing. Defining a beneficial use is distinct from designating beneficial uses made on specific water bodies. There is no prioritization schedule for such designations to occur.

Scale:	Statewide
Data Sources:	California Environmental Data Exchange Network (CEDEN); California Office of Environmental Health Hazard Assessment (OEHHA); California Environmental Protection Agency (Cal EPA)
Data Availability:	Type I
Metric:	Concentration of mercury in fish tissue
Screening Status:	Basic

Importance and Screening Considerations

Nearly all fish contain traces of mercury. High levels of mercury in fish, from their surrounding habitat and water bodies, can cause a human consumer to accumulate high levels of mercury themselves. High levels of mercury can lead to serious health issues and concerns in the human nervous system.

Excessive levels of mercury are negatively affecting beneficial use of many waters of the state by making fish unsafe for human and wildlife consumption. Although mercury occurs naturally in the environment, mercury concentrations exceed background levels because of human activities. Setting mercury objectives will provide useful goals to help keep California's water quality throughout the state safe for sacred ceremonies and cultural practices.

Currently, there are only beneficial uses defined on specific water bodies and no beneficial uses have been designated. As such, the data are not viable for assessing progress toward meeting statewide

mercury objectives pertaining to tribal traditional and cultural use at this time. However, evaluation of this indicator does include measurement of mercury concentrations in fish tissue throughout the state.

This indicator is considered a Basic level indicator. OEHHA monitors mercury levels in fish and provides fish consumption advisories and safe eating guidelines to the public. This indicator can be easily understood by decision makers, making it supportive of decision making.

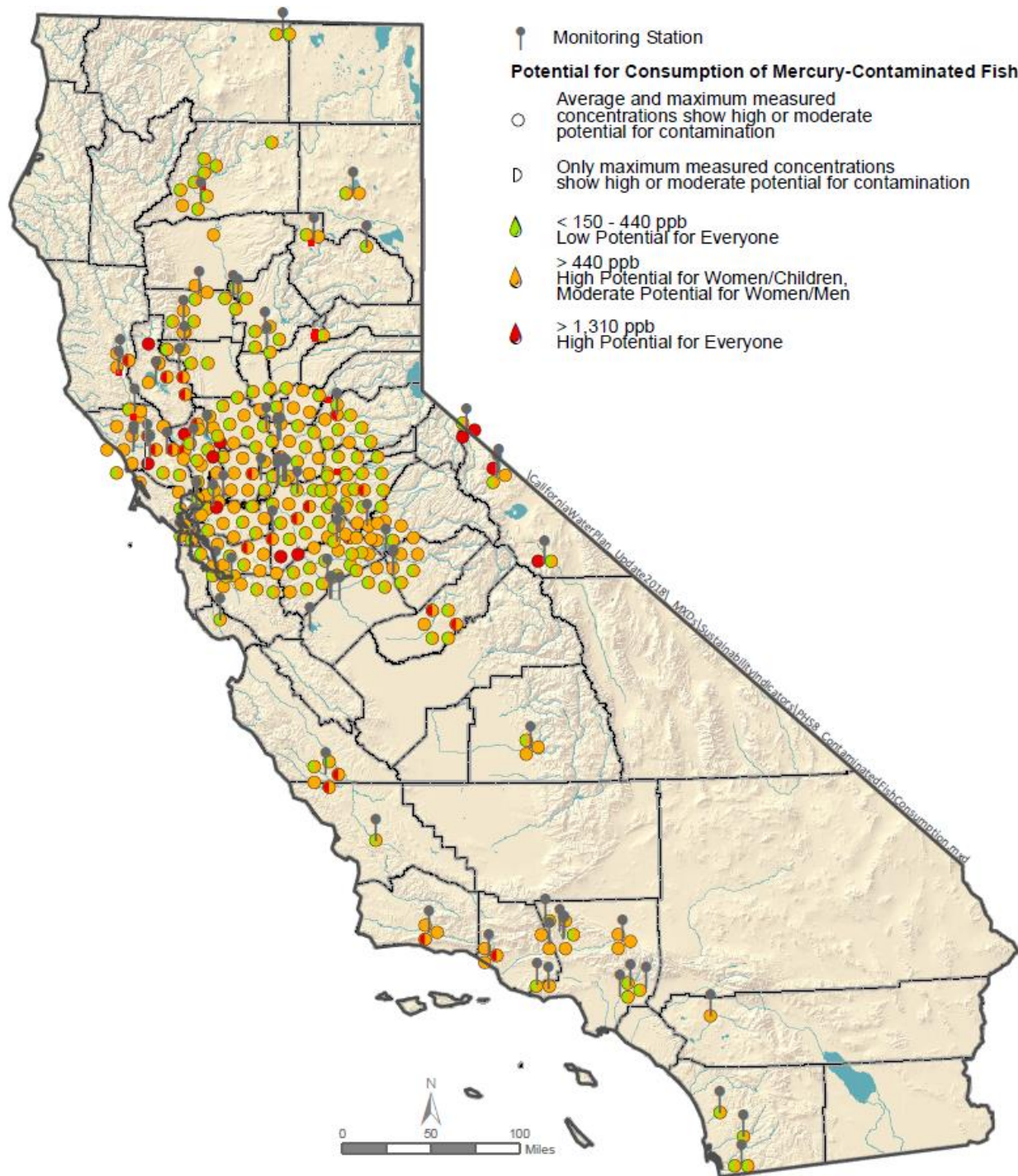
Representative of Outcome:	High
Data Viability:	Medium
Cost:	High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Data on mercury concentrations in fish are available on CEDEN. This database is a central location to access and share information about California's water bodies, including streams, lakes, and rivers, and the coastal ocean. CEDEN aggregates the monitoring data gathered from multiple groups in California and makes it accessible to environmental managers and the public. Data on tissue monitoring are organized by the monitoring program name, monitoring project name, and monitoring stations. These data can be downloaded in a spreadsheet format.

Although there are multiple monitoring programs found on CEDEN, this indicator focuses on the programs and projects that measure the total mercury concentrations in fish species at monitoring stations throughout the state. The most recent available 5-year dataset is from June 16, 2011, to June 16, 2016. From the data, both the average and maximum mercury concentrations (in parts per billion (ppb)) were evaluated. Figure 4-4 illustrates the potential for consumption of contaminated fish at each monitoring station. Some stations have more fish monitoring than others, which is demonstrated through point clusters around each monitoring station.

OEHHA sets an Advisory Tissue Level (ATL) for mercury concentrations in fish. ATLs are designed to encourage consumption of fish that can be eaten in quantities likely to provide significant health benefits, while discouraging consumption of fish that, because of contaminant concentrations, should not be eaten or cannot be eaten in amounts recommended for improving overall health. The ATL varies by gender, age, and serving size. The analysis of this indicator focused on the ATL for one serving of fish per week, which amounted to an 8-ounce serving per week. For women between the ages of 18 and 45 and children between the ages of 1 and 17 (referenced as women/children in Figure 4-4), the recommended ATL for one serving of fish per week is greater than 150 to 440 ppb. For women older than 45 and men (referenced as women/men in Figure 4-4), the recommended ATL for one serving of fish per week is greater than 440 ppb to 1,310 ppb.



Source: California Environmental Data Exchange Network (CEDEN). State Water Resources Control Board. January 23, 2018.

Figure 4-4. Potential for Consumption of Mercury-Contaminated Fish Based on Advisory Tissue Levels Set by California Office of Environmental Health Hazard Assessment

The multiple markers focused at each OEHHA monitoring station represent the different fish species tissue that were monitored for mercury concentration. Table 4-5 shows the average and maximum mercury concentration found in the tissue of each fish species, when over the ATL. Based on average

concentrations, of the 65 fish species monitored over the five-year period, three fish species show elevated levels of risk. Based on maximum mercury concentrations, 12 additional fish species also have been found with elevated mercury concentrations in tissue. Clark's Grebe shows high potential for consumption of contaminated fish by everyone. Western Grebe, Sacramento Pikeminnow, White Sturgeon, and Smallmouth Bass show high potential for consumption of contaminated fish by women/children and moderate potential by women/men. The color used in Table 4-5 matches those used in Figure 4-4 (above).

Table 4-5. Average and Maximum Mercury Concentrations in Fish Tissue Samples from Fish Species Sampled at Monitoring Stations Statewide

Species	Avg. Mercury Concentration (ppb)	Max Mercury Concentration (ppb)
Sacramento Pikeminnow	615	2150
White Sturgeon	521	878
Smallmouth Bass	440	1460
White Catfish	380	734
Sacramento Blackfish	355	521
Sacramento Sucker	308	910
Green Sunfish	297	590
Largemouth Bass	291	1970
Tule Perch	267	505
Striped Bass	211	863
White Croaker	149	453
Common Carp	139	571
Channel Catfish	104	1000
Silverside	79	542
Rainbow Trout	78	616

Source: California Environmental Data Exchange Network. State Water Resources Control Board. January 23, 2018.

Key:

ppb = parts per billions

Notes:

Red shaded cells show high potential for consumption of contaminated fish by everyone. Orange shaded cells show high potential for consumption of contaminated fish by women/children and moderate potential by women/men. Green shaded cells show low potential for consumption of contaminated fish by everyone.

As expected, women/children face a higher potential for consumption of contaminated fish than women/men. The potential for consumption of contaminated fish is also higher in the northern hydrologic regions and watersheds, which could also be attributed to the presence of more fish species at each monitoring station and more water bodies in those regions.

ATLs are one component of the process to determine fish consumption advisories. Other factors are included in the complex process of data evaluation and interpretation of fish consumption risks, such as the omega-3 fatty acid levels and seasonal effects on contaminant data. Therefore, this indicator only represents the potential for consumption of mercury-contaminated fish and is not a fish consumption advisory.

Recommendations

At this point, this indicator is a Basic level indicator, but the guidelines and framework for measuring the indicator will continue to develop as more data and a refined methodology become available. In the future, a method to show the fish species found at each monitoring station may be useful for revealing any associations of those species and high mercury concentrations.

Specifically evaluating the mercury concentrations in waters that would eventually be designated for beneficial use pertaining to other cultures or individuals would indicate progress towards meeting the corresponding mercury objectives.

References

State Water Resources Control Board. California Environmental Data Exchange Network (CEDEN). Viewed online at: <http://www.ceden.org/>. Last accessed: January 23, 2018.

Klasing, Susan, PhD and Robert Bordberg, PhD. Table updated 2017. Development of Fish Contaminant Goals and Advisory Tissue Levels (ATLs) for Common Contaminants in California Sport Fish. California Environmental Protection Agency. Viewed online at: <https://oehha.ca.gov/media/downloads/fish/report/atlmhgandothers2008c.pdf>

State Water Resources Control Board. “Statewide Mercury Provisions.” State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/mercury/. Last accessed: January 23, 2018.

Public Health and Safety

Intended Outcome: Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure)

PHS 7: Population Served by Hazard Mitigation Plans, Emergency Response Plans, or Equivalents

This indicator assesses the population served by Local Hazard Mitigation Plans, Emergency Response Plans, or equivalent plans. The target outcome for this indicator is 100 percent of the population having coverage under Local Hazard Mitigation Plans, Emergency Response Plans, or equivalents.

Local Hazard Mitigation Plans provide opportunities for communities to focus on public involvement, risk assessment, and mitigation strategies. These plans help prevent loss of life, injuries, and damage to infrastructure and other community assets. Emergency plans provide guidance during catastrophic events and/or system failures to achieve the same goals.

Scale:	Statewide
Data Sources:	California Governor’s Office of Emergency Services (Cal OES); Census Data
Data Availability:	Type II
Metric:	Status of Local Hazard Mitigation Plans
Screening Status:	Basic

Importance and Screening Considerations

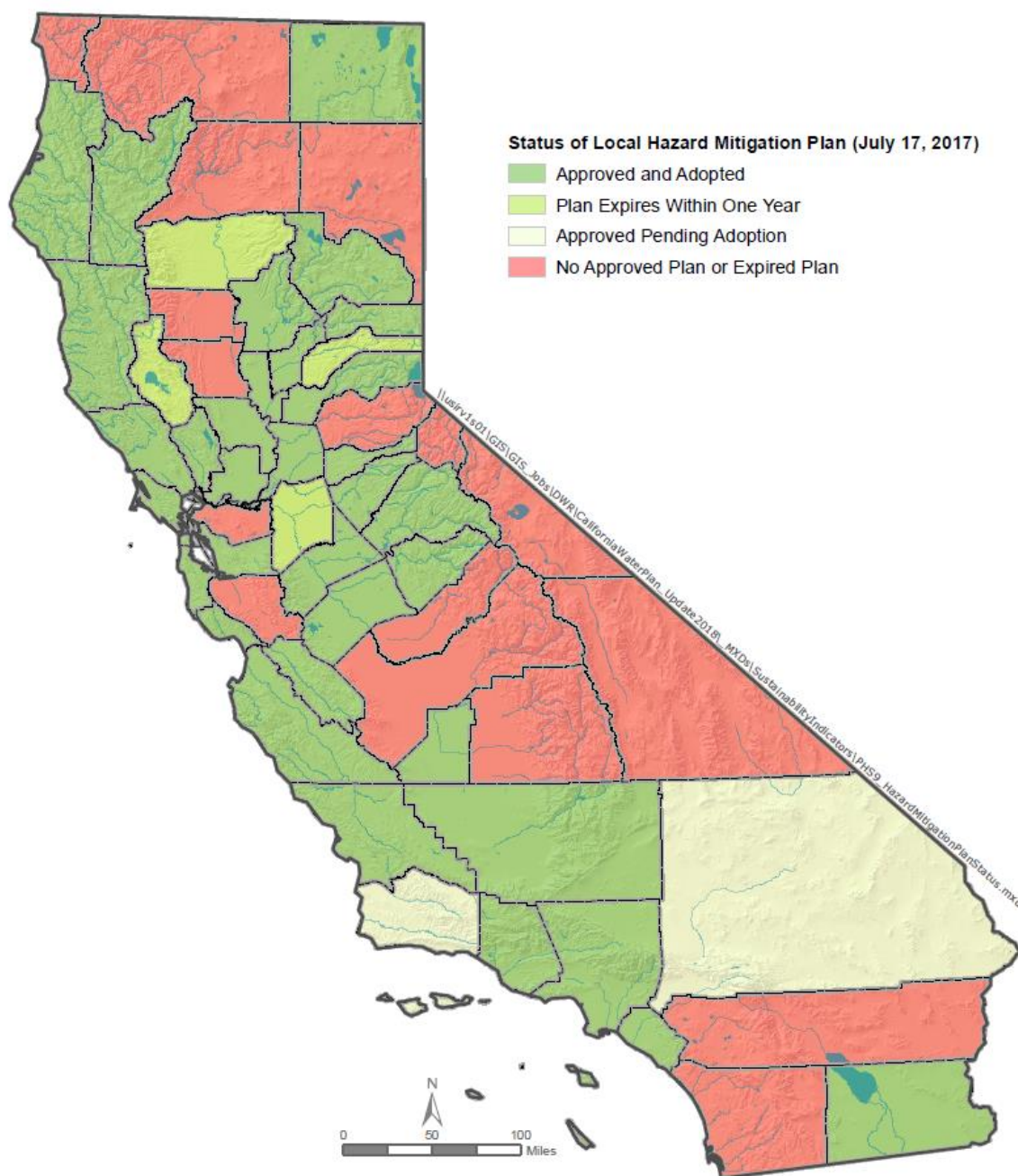
California faces numerous risks and threats to its people, property, economy, environment, and is prone to earthquakes, floods, significant wildfires, and drought impacts. While hazards cannot always be prevented, mitigation planning focuses on reducing the impact of such events when they do occur. In California, hazard mitigation planning is particularly important for emergency response during flood, fire, and drought events.

This indicator is categorized as a Basic level. Comprehensive datasets are partly available, but some communities may not have emergency plans if they are not required. Counties are heavily encouraged to develop Federal Emergency Management Agency (FEMA)-approved Local Hazard Mitigation Plans, but no regulatory requirements exist. As presented in the Initial Data and Results section below, only data on Local Hazard Mitigation Plans were evaluated due to limited access to tracking of community or local level emergency response plans. Therefore, this indicator may not be as supportive of decision making as others at this time.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

Initial Data and Results

Figure 4-5 shows the status of Local Hazard Mitigation Plans throughout California, as of July 17, 2017. These data are maintained by Cal OES. Cal OES works to anticipate and enhance prevention and detection capabilities to protect the state from all hazards and threats. Cal OES assists local and State agencies in developing their own emergency preparedness and response plans and also develops and maintains the State Emergency Plan.



Source: "Local Hazard Mitigation Program – Local Mitigation Planning." Cal OES. December 7, 2017.

Figure 4-5. Status of Local Hazard Mitigation Plans

As shown in Table 4-6 below, approximately 25 percent of the California population is not covered by a Local Hazard Mitigation Plan. However, about 65 percent of the population is covered by an approved and adopted plan. The other 10 percent of the population is either covered by an approved and adopted plan that expires within one year or is covered by a plan that is approved, but pending adoption.

Table 4-6. Population Covered or Not Covered by Local Hazard Mitigation Plans as of July 17, 2017

Status of Local Hazard Mitigation Plan	Population	Percent of Statewide Population
Approved and Adopted	24,984,427	65.1%
Approved and Adopted by Expires Within One Year	974,636	2.5%
Approved Pending Adoption	2,610,919	6.8%
No Approved Plan or Expired Plan	9,836,161	25.6%

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. In the future, data collection could be simplified if local counties were required to report on the status and location of their emergency planning documents on a centralized site. In addition, this indicator may require additional work with local municipalities to include plans created at a community-level rather than at a county-level.

The data used for this Figure 4-5 could be combined with population data for each county to visually display the population not served by a Local Hazard Mitigation Plan. In addition, populations covered by plans at a local, state, and county level or only at more regional levels may need to be considered separately. The level of planning may impact the effectiveness of these plans.

This indicator has the potential to become a central asset in evaluating the state's level of preparedness in the face of natural disasters or extreme hydrologic conditions.

References

California Governor's Office of Emergency Services. 2015. 2014 - 2018 Strategic Plan Summary. Version 1. Viewed online at:

[http://www.caloes.ca.gov/NewsMediaSite/Documents/Cal%20OES%20Strategic%20Plan%20Summary%20Booklet%20\(FINAL\).pdf](http://www.caloes.ca.gov/NewsMediaSite/Documents/Cal%20OES%20Strategic%20Plan%20Summary%20Booklet%20(FINAL).pdf)

Governor's Office of Emergency Services. "Local Hazard Mitigation Program - Local Mitigation Planning." Cal OES. Viewed online at: <http://www.caloes.ca.gov/cal-oes-divisions/hazard-mitigation/hazard-mitigation-planning/local-hazard-mitigation-program>. Last accessed: December 7, 2017.

Public Health and Safety

Intended Outcome: Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure)

PHS 8: Population Covered by Water Shortage Contingency Plans

This indicator assesses the percentage of the population covered by Water Shortage Contingency Plans (WSCP). In a drought year, the state may not have enough water to meet all water demands. Drought preparedness plans, which are a component of a WSCP, help ensure communities can plan for prolonged periods of drought.

The target outcome for this indicator is 100 percent of the population having coverage under WSCPs.

Scale:	Statewide
Data Sources:	UWMPs
Data Availability:	Type II
Metric:	Percentage of Population Covered by WSCPs in Each Hydrologic Region
Screening Status:	Basic

Importance and Screening Considerations

In recent years, dry conditions statewide have underscored the importance of water use efficiency and achieving greater climate and drought resilience and preparedness. 2012 through 2014 are on record as California's driest three consecutive years with respect to statewide precipitation, and 2013 was the driest on record in numerous communities across the state.

During the recent drought (2011-2017), many communities were unable to provide stable, safe water supplies to their residents for household uses. In response to the persistent dry conditions, numerous executive orders directed local urban water suppliers to immediately implement WSCPs, among other actions.

This indicator is considered a Basic level indicator. Data on the status of WSCPs are available through UWMPs, which are plans that focus on water planning at the local water supplier level. Assessing the overall coverage and extent of existing WSCPs can help direct attention to areas where additional work is required to prepare for drought. As previously noted, droughts are an inherent occurrence in California, so this indicator is representative in the short-term and long-term as drought preparedness plans or WSCPs continue to play an important role in protecting public health and safety.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

The Urban Water Management Planning Act requires water agencies to develop UWMPs. A UWMP provides a framework for long-term water planning and informing the public of a supplier's plans for

ensuring adequate water supplies to meet existing and future demands. Among other requirements, an urban water supplier is required to report, describe, and evaluate its water shortage contingency planning.

According to DWR's *2015 Guidebook for Urban Water Suppliers*, an urban water supplier is defined as a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. This also includes a supplier or contractor for water, regardless of the basis of right, which distributes or sells for ultimate resale to customers.

Each UWMP has a distinct service area boundary that may extend beyond a city or county boundary. Some service boundaries may even encompass several city or district boundaries. Displaying whether or not an area is covered by a WSCP requires extensive manual input of service area boundaries at this time. Table 4-7 provides placeholder data pending future development of a map. Currently, the only centralized geographic data for all the urban water suppliers are coded by hydrologic region. Recommendations for further development of an indicator map to support a more thorough evaluation of this indicator are described in the recommendations below.

As demonstrated in Table 4-7, nearly 100 percent of the population in the South Coast and San Francisco Bay regions is covered by WSCPs. Overall, about 91 percent of the California population is covered by WSCPs. The total population that is covered by a UWMP has already achieved the target outcome of 100 percent of the population covered by a WSCP. In order to get to 100 percent of the total state population covered by a WSCP, the state would need to change the minimum threshold for preparing a WSCP or require an equivalent plan outside the UWMP framework.

Table 4-7. Number of Retail Urban Water Suppliers with WSCPs and the Percent of Total California Population Served by Urban Water Suppliers with a WSCP in each Hydrologic Region

Hydrologic Region	Number of Retail UWMPs with WSCPs	Percent of California Population Served by Urban Water Suppliers (Retail only) with WSCPs
South Coast	175	99.7%
San Francisco Bay	43	92.9%
Colorado River	12	85.6%
Tulare Lake	38	82.8%
Sacramento River	38	80.4%
Central Coast	38	80.3%
North Lahontan	4	65.8%
San Joaquin River	22	64.8%
North Coast	13	59.7%
South Lahontan	15	57.3%
Statewide	388	91.1%

Sources: Water Use Efficiency Data Public Portal. January 10, 2018.

American Community Survey 5-Year Data (2009-2016). U.S. Census Bureau. January 10, 2018.

Key:

WSCP = Water Shortage Contingency Plan

UWMP = Urban Water Management Plan

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

Private and public water agencies develop UWMPs and WSCPs. Some of the UWMPs are for cities while others are for counties and some are even for private water agencies. As previously mentioned, there are no consistent boundaries for service area boundaries that each UWMP covers. To display this information on a geo-referenced map in the future, it is recommended that DWR require geospatial map layers of each urban water supplier boundary as part of the next round of UWMP updates. The *2015 UWMP Guidebook for Urban Water Suppliers* states that DWR's preference is to obtain electronic service area boundary maps. Rather than stating this as a preference in the Guidebook, DWR should require that a geospatial map layer of the service area be submitted. The following metadata should be included: map projection, contact information for the map's creator, start and end dates for which the map is valid, constraints, attribute table definitions, and a digitizing base. Requiring the geospatial map layer would eliminate the need to manually define the boundary of each UWMP to create a map that would geographically show areas that are covered or not covered by WSCPs.

Once service area boundaries are defined and mapped, the map should display the status of DWR's review of each WSCP through a color scale (e.g., reviewed, not yet reviewed, and under review).

In 2018, the Legislature enacted two policy bills – SB 606 and AB 1668 – to establish both the foundation and needed authorities for long-term improvements in water conservation and drought planning to adapt to climate change and the resulting longer and more intense droughts in California. These bills amended the California Water Code, requiring state agencies to develop statewide water use targets, standards, and guidelines, and water agencies to then report on progress towards meeting those requirements. During the implementation process, DWR and other State agencies will further develop data, information, guidelines, and other technical assistance to help realize the bills' intended outcomes. Both bills include requirements for public access to data and their use, as well as related studies, reports, and investigations. These data, studies, reports, and investigations may be of use to continued development of this indicator.

References

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- U.S. Census Bureau. "American Community Survey 5-Year Data (2009-2016)." Viewed online at: <https://www.census.gov/data/developers/data-sets/acs-5year.html>. Last accessed: January 10, 2018.

Public Health and Safety

Intended Outcome: Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure)

PHS 9: **Urban Population without State-Mandated Urban Level of Flood Protection**

This indicator assesses the urban population without the Urban Level of Flood Protection Criteria mandated in the Central Valley Flood Protection Act of 2008. The target outcome for this indicator is all urban and small communities¹ have the appropriate level of flood protection.

Scale:	Statewide
Data Sources:	DWR; Central Valley Flood Protection Plan (CVFPP)
Data Availability:	Type II
Metric:	Population within Floodplains
Screening Status:	Basic

Importance and Screening Considerations

California is at risk for catastrophic flooding that could have wide-ranging impacts due to the size of its economy and the number of people residing in the state. Flooding can affect California at different times of the year and in different forms – from storm water flooding in urban areas to alluvial fan flooding at the base of hillsides. One in five Californians live in a floodplain. Four of the nation’s largest cities (Los Angeles, San Diego, San Jose, and San Francisco) are all at risk for some type of flooding. All California counties having some level of exposure.

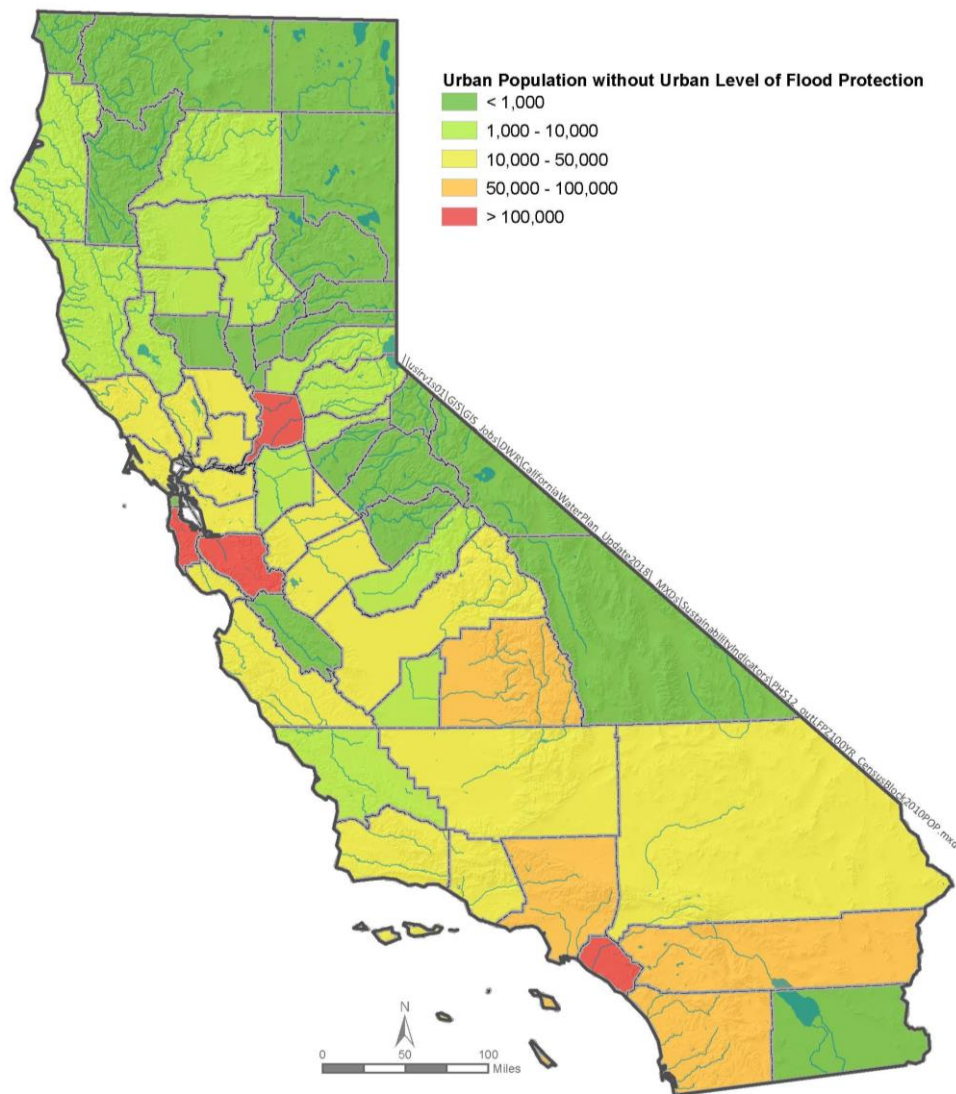
Central Valley cities and counties that wish to continue to develop in urban and urbanizing areas are required to achieve an urban level of flood protection (200-year flood), defined in California Government Code Section 65007(l) and California Water Code Section 9602(i). New development in non-urbanized areas, including small communities, must meet the national FEMA standard of flood protection, per California Government Code Sections 65865.5, 65962, and 66474.5. This corresponds to the minimum level of flood protection (100-year flood) required to remove or exclude an area or community from a Special Flood Hazard Area as defined by FEMA. Outside the areas protected by SPFC facilities, the State supports achieving appropriate levels of flood protection, particularly for existing urban and adjacent urbanizing areas.

Overall, this indicator was categorized as a Basic level indicator. This indicator relates directly to the State’s efforts towards lowering the risk associated with flooding in developed urban and adjacent urbanizing areas. Data are readily available from DWR to assess the urban population at risk in the Central Valley but not in the rest of the state.

Representative of Outcome:	High
Data Viability:	High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

To assess this indicator, California Department of Transportation's (Caltrans) 2010 Adjusted Urban Areas data were spatially compared with DWR's Best Available Maps. For urban areas in the Central Valley with populations greater than 10,000 people, the population living within the 200-year floodplain was counted. For small communities as well as large communities outside of the Central Valley, the population living in the 100-year floodplain was counted. The 100-year floodplain was developed by DWR's SFMPP that conducted an in-depth analysis in November 2012. The 200-year floodplain was developed by a U.S. Army Corps of Engineers (USACE) comprehensive study and is included as DWR's Best Available Maps. The floodplain maps were adjusted when the land was protected by State Plan Flood Control (SPFC) Facilities, as mapped by the Levee Flood Protection Zones from DWR. Population information was based on 2010 Census Blocks. Figure 4-6 summarizes this information to develop an estimate of the urban population without Urban Level of Flood Protection in each county.



Sources: "Levee Flood Protection Zone", Best Available Maps USACE Comprehensive Study 200-year Floodplain, Flood Hazard Exposure Analysis 100-year Floodplain, TIGER Products, U.S. Census Bureau, CalTrans GIS Data.

Figure 4-6. Urban Population Without State-Mandated Urban Level of Flood Protection

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

DWR has made the tools, data, and other relevant information available to support findings related to urban level of flood protection. By continuing to update this information and make it publicly accessible, policy makers as well as the public can make informed decisions to mitigate the risk of catastrophic flooding that the state currently faces.

References

California Department of Water Resources. "Central Valley Flood Protection Plan." California Department of Water Resources. Viewed online at: www.water.ca.gov/cvfmfp. Last accessed: February 6, 2018.

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California Department of Water Resources. "Levee Flood Protection Zone." California Department of Water Resources. Viewed online at: <http://gis.lfpz.water.ca.gov/lfpz/>. Last accessed: February 12, 2018.

California Department of Water Resources. 2013. Statewide Flood Management Planning Program Attachment F: Flood Hazard Exposure Analysis. California Department of Water Resources.

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California Department of Transportation. "CalTrans GIS Data." Viewed online at: <http://www.dot.ca.gov/hq/tsip/gis/datalibrary/>. Last accessed: December 12, 2017.

Public Health and Safety

Intended Outcome: Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure)

PHS 10: Population in Floodplains with Equal to or Greater than a 1 Percent Chance of Flooding in any Given Year

This indicator assesses the population that lives in floodplains with equal to or greater than a 1 percent chance of flooding in any given year (also defined as a 100-year floodplain) throughout the state. This indicator differs from *PHS 9, Urban Population without State-Mandated Urban Level of Flood Protection*, in that it includes rural agricultural areas, in addition to urban areas and small communities. Information from the archived indicator *PHS, Population in Floodplains with Equal to or Greater than 0.2 Percent Chance of Flooding in any Given Year* is provided to include consideration of areas that have a 1-in-500 chance of flooding in any given year. The target outcome for this indicator is zero percent of the population lives in 100-year floodplains (residential population) without appropriate flood risk mitigation.

During initial indicator development, some feedback related to reflecting more frequent flooding events (i.e., 2 percent chance of flooding in any given year, or 50-year floodplains). As the state is experiencing extreme events (droughts and floods) of both greater frequency and intensity, and no State or Federal agencies currently develop or maintain 50-year floodplain maps, this indicator was formulated and initially evaluated for 100-year floodplains.

Scale:	Statewide
Data Sources:	FEMA, Department of Finance, U.S. Census Bureau
Data Availability:	Type III
Metric:	Population
Screening Status:	Basic

Importance and Screening Considerations

State, Federal, and local agencies have made significant investments in the state's flood management system, including levees and bypasses. While these structures help reduce risk, a floodplain can never be fully protected, and significant inhabited land lies outside of the protected areas from these facilities. This indicator was developed using data from DWR, FEMA, and the U.S. Census Bureau to delineate the population at risk living in 100-year floodplains throughout California.

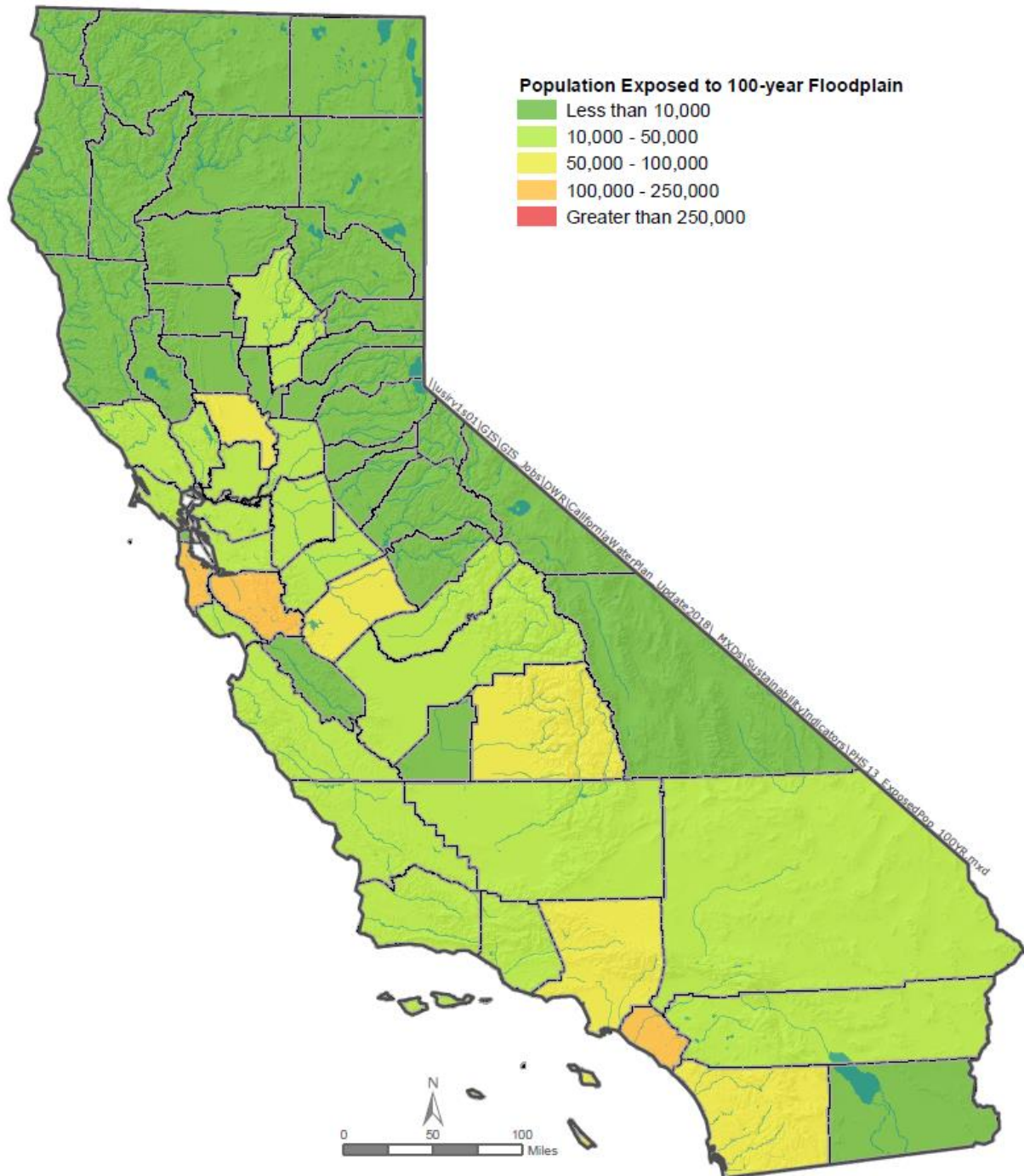
Overall, this indicator is categorized as a Basic level indicator. However, data are incomplete in some regions of the state, and FEMA floodplain maps are likely out-of-date in some regions. Additional analysis or surveying may be required to obtain a complete and recent dataset for a full analysis.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Low
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

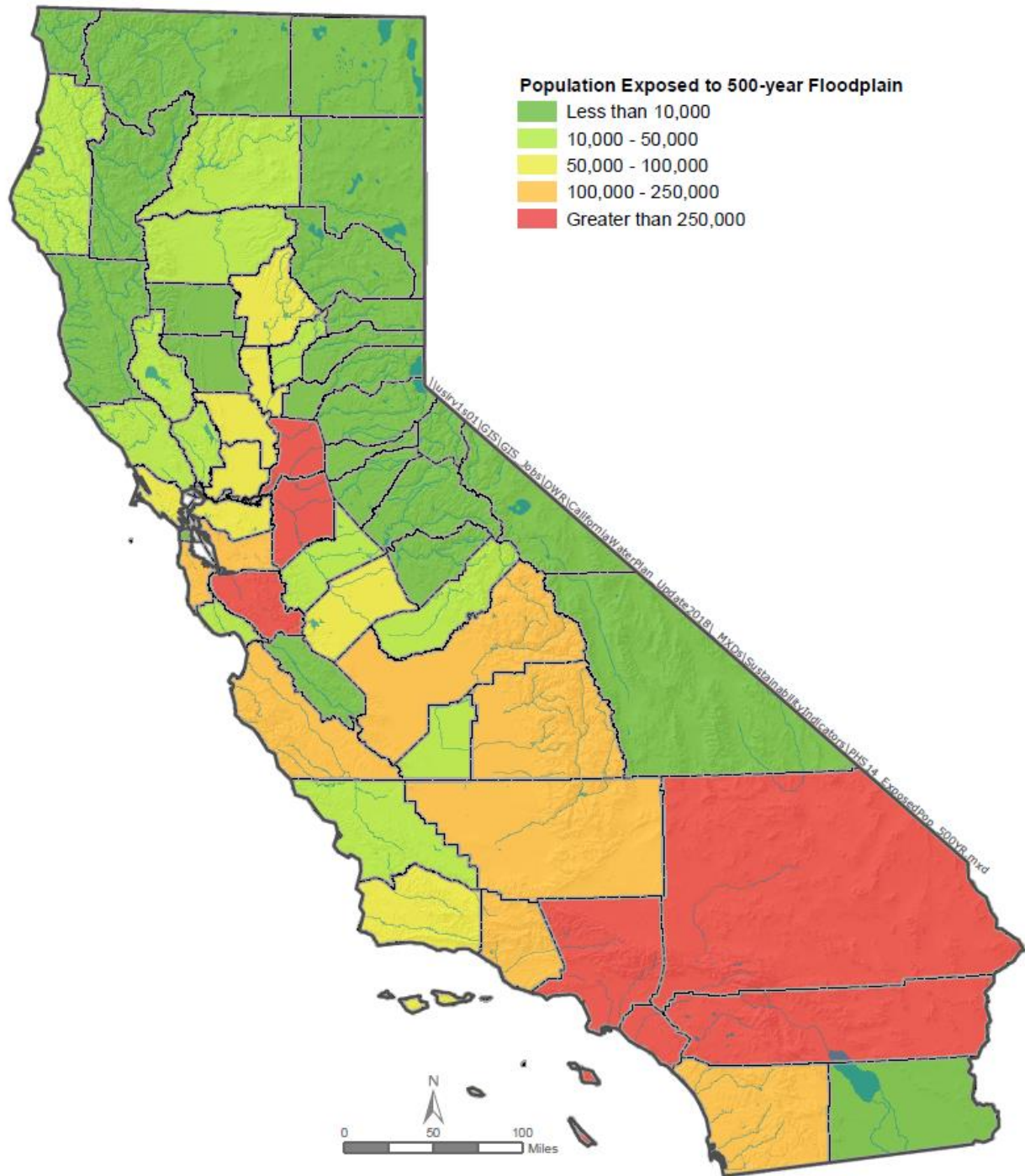
The methodology for this indicator was developed by DWR's SFMPP that conducted an in-depth analysis in November 2012 of flood exposure risks throughout California. Results from the latest update on the exposure analysis conducted through this study are presented in Figure 4-7 and Figure 4-8. The floodplains used for this analysis included either detailed 100-year and 500-year floodplain extents developed for the CVFPP, where available, or FEMA Flood Insurance Rate Maps. Populations were based on FEMA Hazus data taken from the 2000 census.

Exposure to flood hazards exist across the state, with the potential for the greatest damage concentrated in developed urban areas. Figure 4-7 shows the population exposed to a 1 percent chance of flooding in any given year. Significantly more of the state's population is exposed to a 0.2 percent chance of flooding, as shown in Figure 4-8. Across California, at every risk threshold, large urban areas have the greatest number of people at risk of flooding in any given year.



Source: Statewide Flood Management Planning Program – Attachment F: Flood Hazard Exposure Analysis.
California Department of Water Resources.

Figure 4-7. Population Exposed to 100-year Floodplain



Source: Statewide Flood Management Planning Program – Attachment F: Flood Hazard Exposure Analysis. California Department of Water Resources.

Figure 4-8. Population Exposed to 500-year Floodplains

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

Flooding is a common occurrence in California, so many agencies have already collected data on floodplains throughout the state, including DWR, USACE, and FEMA. A future methodology for evaluating this indicator should involve compiling and reconciling data from DWR, USACE, and FEMA to determine the most accurate limits of 100-year floodplains throughout the state. Additional surveying may also be needed to supplement and update the data from these agencies.

A future methodology could also incorporate risk-based mapping. Risk-based maps that show a comprehensive assessment of the area's flood risk in easily understandable terms could increase public understanding of flood risk and management. For example, DWR has developed floodplain maps for 10 urban communities in the Central Valley (Chico, Yuba City, Marysville, Woodland, Davis, Sacramento, West Sacramento, Stockton, and Lathrop) that include information regarding water surface elevations for a 200-year flood event. Although not yet applicable to 100-year floodplains, this evolving source of data should be considered as a potential source of additional information that may be adapted for this indicator.

The appropriate level of flood protection for varying densities of residential development should be considered and incorporated into this indicator.

References

Taylor, Mac. 2017. Managing Flood in California. Legislative Analyst's Office. Viewed online at: <http://www.lao.ca.gov/reports/2017/3571/managing-floods-032217.pdf>

California Department of Water Resources. "Central Valley Flood Protection Plan." California Department of Water Resources. Viewed online at: www.water.ca.gov/cvfmfp. Last accessed: February 6, 2018.

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Ecosystem Vitality

Intended Outcome: Maintained and increased ecosystem and native species distributions in California while sustaining and enhancing species abundance and richness.

EV 1: Native Fish Diversity Index

This composite indicator assesses several components that together provide a composite Native Fish Diversity Index. This indicator is adapted from the Community Diversity Index presented in the *California Water Sustainability Indicators Framework: Assessment at State and Regional Scale* final report, published within the CWP Update 2013 materials.

The Native Fish Diversity Index, currently under development, would combine information on the following four metrics to provide a thorough evaluation of fish habitat throughout different California watersheds:

- Native fish conservation status – describes threatened and endangered species
- Percentage of expected native fish species observed in watersheds – describes environmental conditions and disturbances
- Proportion of non-native fish species – shows areas of heavy disturbance
- Status of several key fish species into a single index – emphasizes species that have experienced rapid declines in the past decades, such as the Central Valley Chinook Salmon or the Delta Smelt

The target outcome for this under-development indicator is a high index value, once a quantitative scoring system is established. A high index value would indicate that native fish species are neither endangered or threatened, environmental disturbance is low, and key fish species are thriving.

Scale:	Statewide
Data Sources:	UC Davis PISCES; California Department of Fish and Wildlife (CDFW); CWP Update 2013
Data Availability:	Type I
Metric:	Composite index of native fish conservation status, percent of expected native fish species, proportion of non-native fish species, and status of key fish species
Screening Status:	Basic

Importance and Screening Considerations

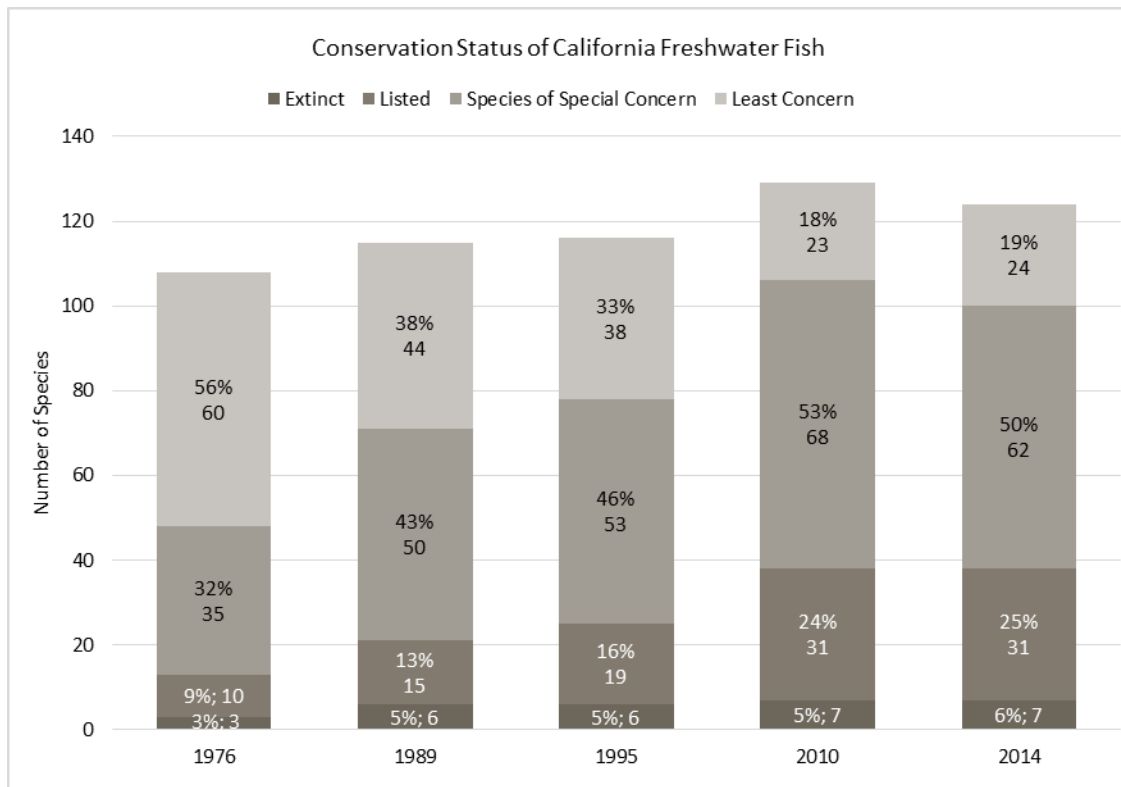
Varying and distinct conditions throughout California watersheds have inherently produced diverse fish species, many endemic to California. Fish habitats vary widely from desert pools to estuaries to high mountain lakes. Many of these habitats are facing habitat loss or disturbance due to expansion of human communities and climate variability. A composite indicator would show the status of fish species across the state and would be used as a tool to recognize areas of high and low watershed and stream ecosystem health.

At present, this under-development indicator is considered a Basic level indicator. This indicator directly represents native species distributions and richness throughout the state. Some data analysis must be performed to convert monitoring information into the intended metric. Some data are currently available through PISCES, a comprehensive database maintained by University of California (UC) Davis that compiles the best-known ranges for California's native fish as well as many non-native fish. However, additional data on invasive species are currently lacking. This indicator may reveal additional information about the impact of stressors on native fish communities, including introduced species, anthropogenic activities, and habitat conversion or degradation, making it supportive of decision making.

Representative of Outcome:	High
Data Viability:	High-Medium
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Native Fish Conservation Status. The conservation status of native fish over time since 1976 is shown in Figure 4-9 as reported in several studies, including the 2015 Fish Species of Special Concern in California, 3rd edition, published by CDFW. This report presents information on all California's Species of Special Concern, representing 81 percent of California's freshwater fish, as a continuation of similar past reports (Moyle 1976, Moyle et al. 1989, Moyle et al. 1995, Moyle et al. 2015).

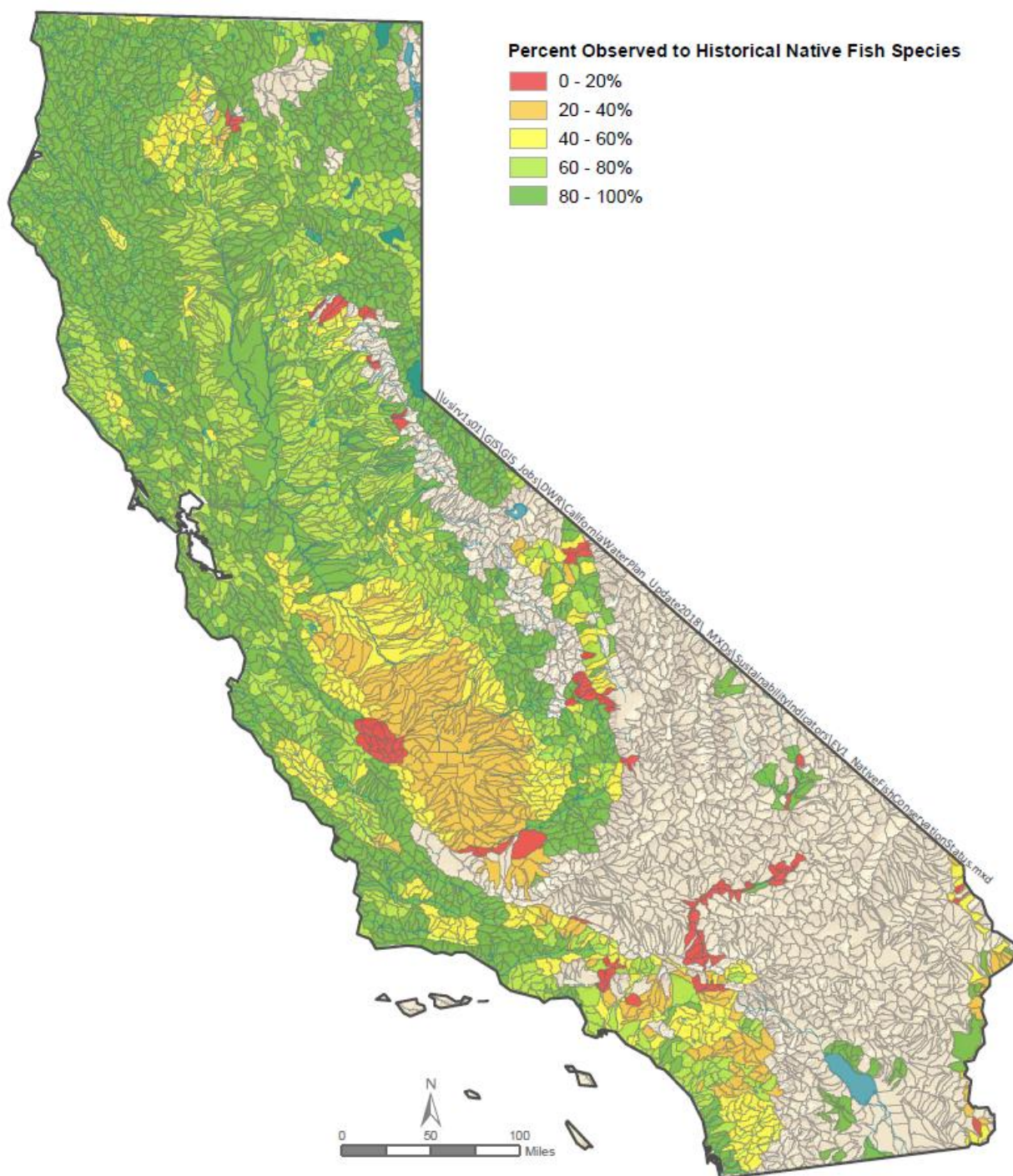


Sources: Moyle 1976, Moyle et al. 1989, Moyle et al. 1995, Moyle et al. 2015

Figure 4-9. Conservation Status of California Freshwater Fish

Percentage of Expected Native Fish Species Observed in Watersheds. The percentages of observed native fish species compared to the historical native fish species in individual watersheds were calculated using the range data provided through PISCES. This analysis assumed the full extent of all ranges, regardless of season, adding to the species richness in all watersheds.

All species included in the database at the time of the analysis were used. For each watershed, the number of observed fish species was compared to the number of historical fish species to derive a final percentage. Watersheds with more observed fish species than historical fish species were given a 100 percent richness percentage score. Watersheds with no historical fish species are not shaded. These watersheds were analyzed on a fine scale anticipate the incorporation of additional data sources and the calculation of a final index score on a larger watershed scale. Figure 4-10 shows the results of this analysis.



Source: "Fish Data." UC Davis PISCES. January 30, 2018.

Figure 4-10. Percent Observed to Historical Native Fish Species

As shown in Figure 4-10, the San Joaquin Valley has lost much of its native fish richness, likely due to heavy modification of natural flow patterns. Upper reaches of watersheds also show losses in fish richness, potentially due to the presence of dams and other fish passage barriers in those areas. Many high

alpine and desert regions in California have not had historical populations of native fish and were not scored in this analysis.

Proportion of Non-Native Fish Species. Data representing a comparison of native and invasive fish populations were not yet developed in a comprehensive database, so this metric was not analyzed.

Status of Several Key Fish Species. No determination of key California fish species for regions of the state has been made for this indicator, therefore this metric was not analyzed.

Recommendations

At present, this under-development indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

To continue development of the Native Fish Diversity Index, additional data and methodology for the final two metrics related to non-native fish species and on key native fish species are required. Data on non-native species are currently only partly developed in PISCES and through CDFW. Key native fish species should be chosen to represent the varied regions in California upon consultation with stakeholders. The conservation status of California freshwater fish should be incorporated into the PISCES database information upon new reports on fish species of special concern in California. This would allow for a geographically distributed review of areas where fish species of special concern are concentrated. In addition, a quantitative calculation of the Native Fish Diversity Index to be applied at a watershed level should be established to allow comparison across the state.

If data remains undeveloped in the near future, this indicator should be redefined to represent available data. Missing components could be formulated as Advanced indicators or more simply formulated to represent available data on fish ranges in California. The redefined indicator would then be “Percentage of Expected Native Fish Species Observed.” A second indicator could be used to emphasize the conservation status of these native fish species or this information could simply be incorporated into the redefined indicator. No key species would be chosen or analyzed. Non-native fish species would be represented in *EV 2: Non-Native Invasive Species Distribution and Status*.

References

Center for Watershed Sciences, University of California, Davis. “Fish Data.” UC Davis PISCES. Viewed online at: <https://pisc.es.ucdavis.edu/fish>. Last accessed: January 30, 2018.

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Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley.

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Moyle, PB, RM Yoshiyama, JE Williams, and ED Wikramanayake. 1995. Fish species of special concern of California. Second edition. California Department of Fish and Game, Inland Fisheries Division. Rancho Cordova, CA.

Ecosystem Vitality

Intended Outcome: Maintained and increased ecosystem and native species distributions in California while sustaining and enhancing species abundance and richness.

EV 2: Non-Native Invasive Species Distribution and Status

This indicator assesses the distribution and status of aquatic non-native invasive species throughout California's watersheds and management responses to eliminate or contain these species.

The target outcome for this indicator is that no invasive species are present in California watersheds, indicating the presence of well-balanced aquatic ecosystems throughout the state.

Scale:	Statewide
Data Sources:	United States Geological Survey (USGS) Nonindigenous Aquatic Species (NAS) Database
Data Availability:	Type I
Metric:	Invasive species distribution and status
Screening Status:	Basic

Importance and Screening Considerations

Invasive species can pose a significant threat to vital and diverse ecosystems. Often introduced unintentionally through human activity, invasive species may have no natural predators in their new habitat. If established, the proliferation of invaders can have far-reaching effects on the species native to the ecosystem as well as for communities who rely on the ecosystem. These effects can include reduction of biodiversity, degradation of water quality, and change in water availability. California is actively involved in efforts to prevent the introduction of invasive species into the state, detect and respond to introductions when they occur, and prevent the spread of invasive species that have become established.

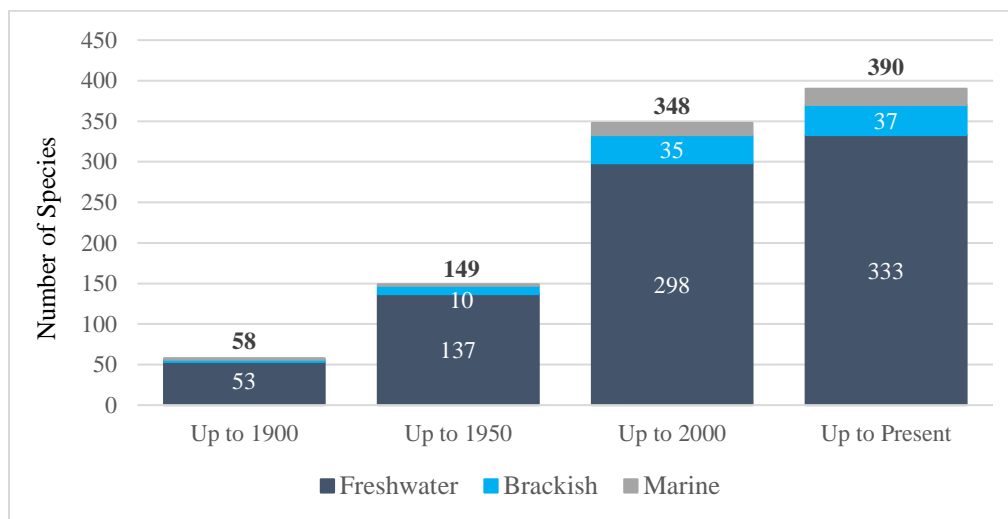
This indicator is considered a Basic level indicator. Data on invasive species distribution and status are developed by a variety of different agencies and organizations. The status and distribution of invasive species may indicate if current preventative measures are effective and the need to establish new policies or guidelines to prevent the spread and presence of harmful invasive species throughout California's watersheds, making the indicator highly supportive of decision making.

Representative of Outcome:	Medium
Data Viability:	Low
Cost:	High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

The NAS Database, maintained by USGS, exists to make relevant and informative data on aquatic invasive species readily available and easy to access. This database was used to procure state-wide aquatic invasive species records, graphs, and maps. Figure 4-11 details the total number of aquatic

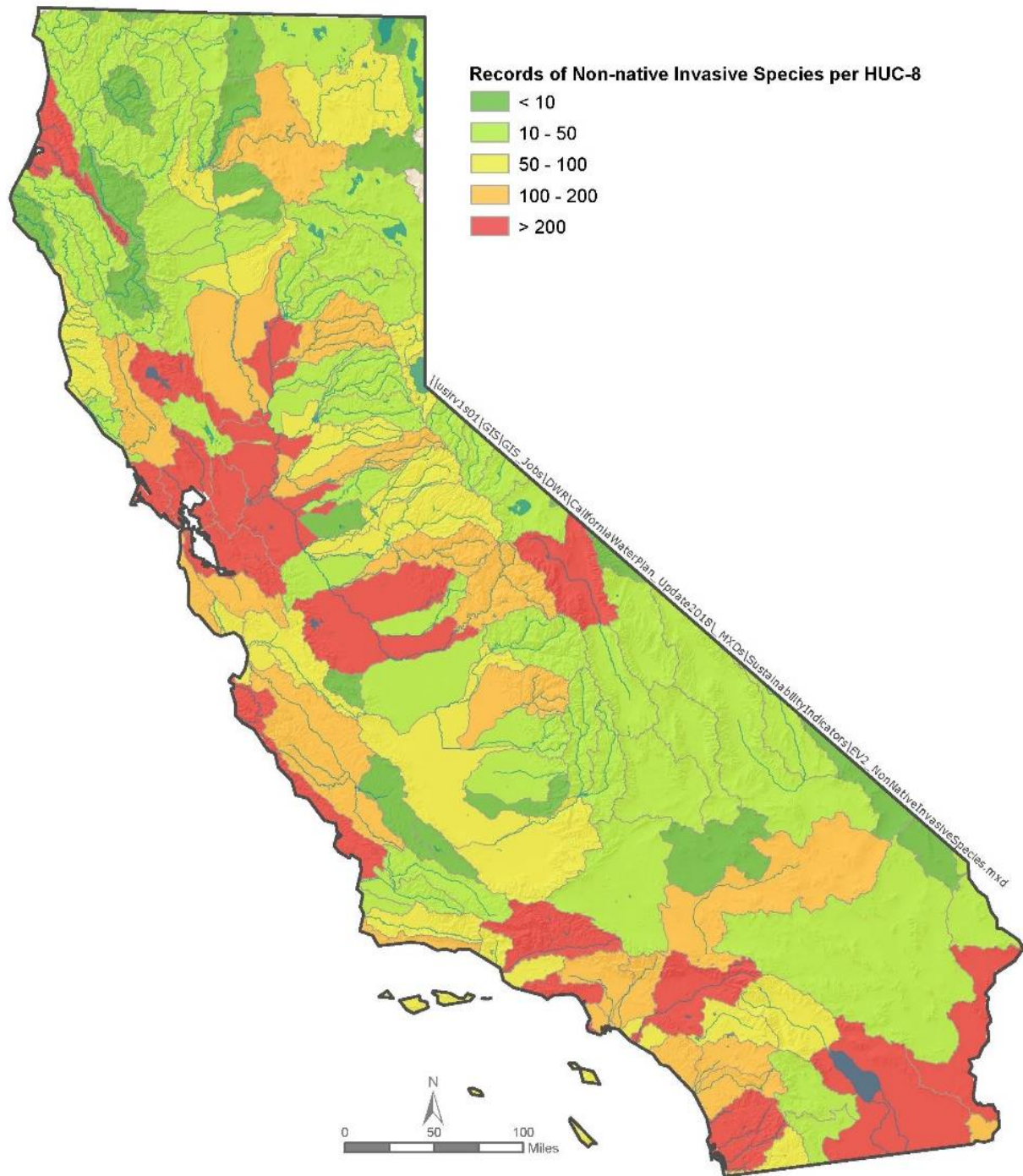
invasive species introduced in the state over time. Note that the introduction of a species does not necessarily equate to the establishment of that species in the new habitat.



Source: USGS NAS Database

Figure 4-11. Freshwater/Marine Species Introduced over Time in California

Figure 4-12 shows the spatial distribution and frequency of various aquatic invasive species records. Note that each record does not necessarily quantify the prevalence of a species in that region or guarantee the future survival or establishment of that species.



Source: USGS NAS Database

Figure 4-12. Distribution and Frequency of Aquatic Invasive Species Records

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

The California Department of Fish and Game (now CDFW) developed the California Aquatic Invasive Species Management Plan in January 2008, and this plan included “Early Detection and Monitoring” as one of eight major objectives. Among the actions included in this objective, programs to support early detection of high priority aquatic invasive species are prioritized. In addition, the plan recognizes the importance of determining the spatial distribution of aquatic invasive species and includes an action to “...include maps of existing aquatic invasive species in California’s coastal and inland waters in the Department of Fish and Wildlife Biogeographic Information and Observation System.” Continued work by CDFW to achieve these objectives will increase the availability of accurate and accessible data.

In 2012, CDFW merged their California Aquatic Non-native Organism Database (CANOD) with the National Estuarine and Marine Exotic Species Information System (NEMESIS), creating the California Non-native Estuarine and Marine Organisms (Cal-NEMO) database. This database was considered for use in this indicator, but was not used due to the limitation of the database to marine and estuarine species only. For a state-wide indicator, it is important to be able to assess freshwater invasive species as well. It is recommended that this database be expanded and used in the future to provide a complete state-managed assessment of the status of non-native aquatic species in California.

References

- Shilling, Fraser. 2014. California Water Sustainability Indicators Framework: Assessment at State and Regional Scale. Final Report. California Department of Water Resources. Prepared by: Department of Environmental Science and Policy at University of California, Davis. Viewed online at: <https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/What-We-Do/Sustainability/Files/Publications/California-Water-Sustainability-Indicators-FrameworkAssessment-at-State-and-Region-Scales--Final-Rep.pdf>
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Ecosystem Vitality

Intended Outcome: Maintained and increased ecosystem and native species distributions in California while sustaining and enhancing species abundance and richness.

EV 3: Acreage of Wetlands

This indicator assesses the distribution and current acreage of wetlands throughout California. Wetlands form transitional areas between water bodies and fully terrestrial ecosystems. Wetlands are found throughout California's ecosystems and serve to regulate climate, store surface water, replenish groundwater aquifers, protect shorelines, serve as critical habitat, and provide opportunities for education and recreation.

The target outcome for this indicator is to maintain or increase the acreage of wetlands in the state.

Scale:	Statewide
Data Sources:	U.S. Fish and Wildlife Service
Data Availability:	Type I
Metric:	Wetland distribution and acreage
Screening Status:	Basic

Importance and Screening Considerations

California currently has approximately 3 million acres of wetlands. These wetlands, despite the important beneficial functions they perform, wetlands are at risk due to urban and agricultural development. A large proportion of historical wetlands have been lost.

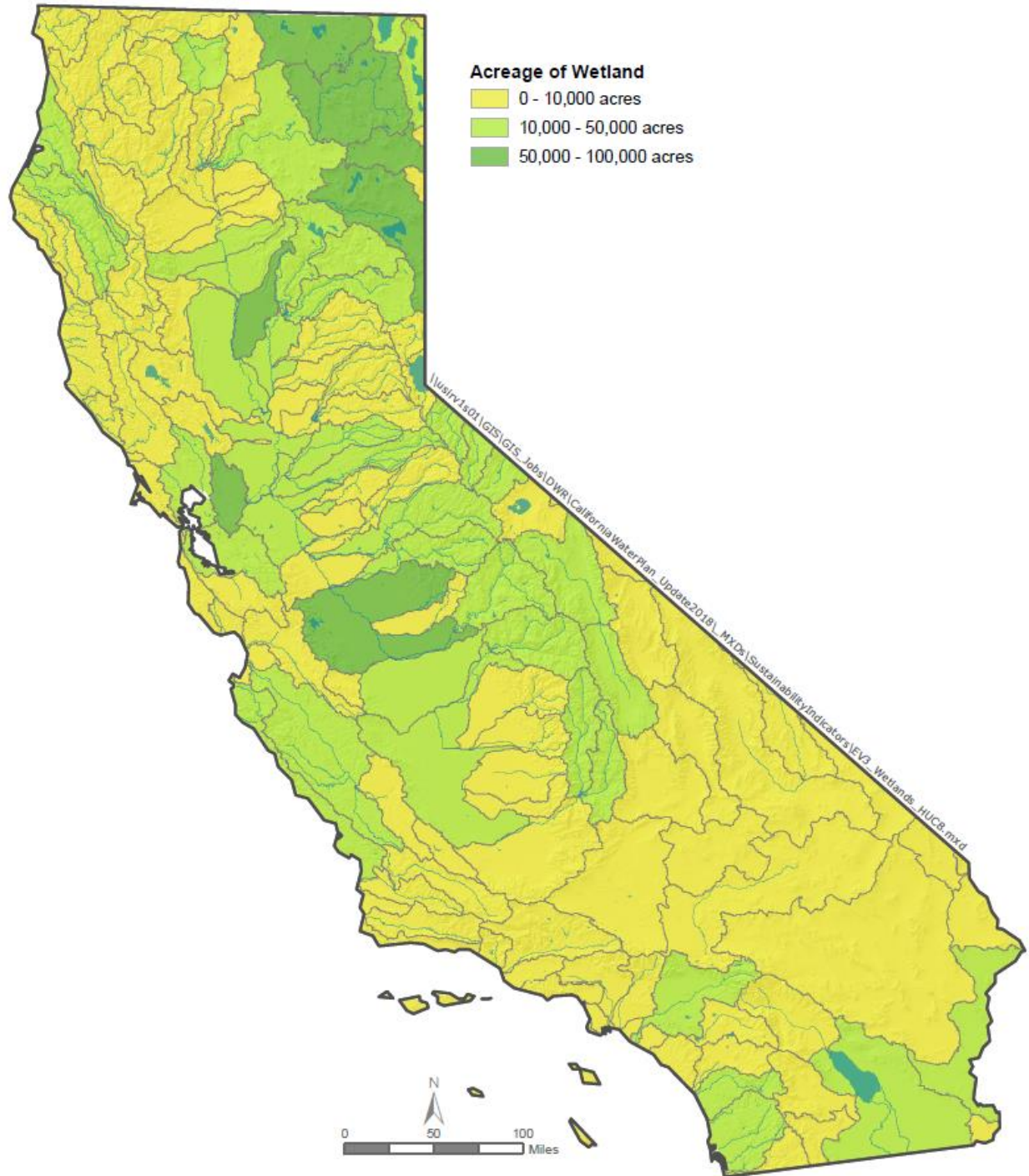
Overall, this indicator is considered a Basic level indicator. Data on wetlands throughout the United States, including California, are collected by the U.S. Fish and Wildlife Service as part of the Wetlands Data Layer of the National Spatial Data Infrastructure. The distribution of wetland acreage directly represents ecosystem distribution in the state and can be used to direct policies or projects to areas that are in particular need, making the indicator highly supportive of decision making.

Representative of Outcome:	Medium
Data Viability:	Low
Cost:	High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

The U.S. Fish and Wildlife Service maintains and distributes the National Wetlands Inventory. This data provides the extent and location of wetlands throughout the United States. Figure 4-13 includes wetlands captured in the National Wetlands Inventory under the Estuarine and Marine, Freshwater Emergent, and Freshwater Forested/Shrub wetland types. The total acreage of wetlands shown is 1,656,000 acres.

Several key areas for existing wetlands in California include northeastern California, the Delta, and watersheds in the Central Valley, especially those containing National Wildlife Refuge areas.



Source: National Wetlands Inventory. May 2018. U.S. Fish and Wildlife Service.

Figure 4-13. Distribution of Wetland Acreage Through California

Table 4-8 illustrates the distribution by type of wetland acreage in California. Freshwater emergency wetland is the most common wetland type by acreage.

Table 4-8. Acreage by Wetland Type

Type	Acreage
Estuarine and Marine Wetland	101,729
Freshwater Emergent Wetland	1,082,922
Freshwater Forested/Shrub Wetland	471,820

Sources: “National Wetlands Inventory Product Summary.” May 8, 2018. U.S. Fish and Wildlife Service.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. Continued efforts to develop the Wetlands Data Layer are underway. Local and state agencies should cooperate with efforts by the U.S. Fish and Wildlife Service to further develop this geospatial data. Trends in acreage should be tracked to understand the impacts of future projects on wetland acreage.

References

Natural Resource Agency. 2010. State of the State’s Wetlands: 10 Years of Challenges and Progress.

Viewed online at:

http://www.resources.ca.gov/docs/SOSW_report_with_cover_memo_10182010.pdf

U.S. Fish and Wildlife Service. “National Wetlands Inventory Product Summary.” Viewed online at:

<https://www.fws.gov/wetlands/Data/Wetlands-Product-Summary.html>. Last accessed: April 12, 2018.

U.S. Fish and Wildlife Service. 2018. “National Wetlands Inventory.” Viewed online at:

<https://www.fws.gov/wetlands/Data/Wetlands-Product-Summary.html>. Last accessed: April 12, 2018.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

EV 4: Degree of Aquatic Fragmentation

This indicator assesses the degree of aquatic fragmentation. Aquatic fragmentation identifies the proportion of the stream segments crossed by artificial structures, such as dams and roads. This indicator is adapted from the *California Water Sustainability Indicators Framework: Assessment at State and Regional Scale* final report, published within the CWP Update 2013 materials.

The target outcome for this indicator is for 100 percent of watersheds to be unfragmented. This increases ecological health by allowing aquatic species and systems to thrive through the conservation of the historical natural watershed connectivity.

Scale:	Statewide
Data Sources:	U.S. Geological Survey National Hydrography Dataset (NHD); CalTrans; U.S. Forest Service; CDFW Passage Assessment Database (PAD); CWP Update 2013
Data Availability:	Type II
Metric:	Density of road intersections and dams along streams
Screening Status:	Basic

Importance and Screening Considerations

Streams and rivers throughout California watersheds are disconnected by physical barriers, including dams, culverts, in-stream impoundments, or segmented due to sections with high temperature or excessive aquatic plant growth. Assessing watershed connectivity is critical to understanding effective conservation of rivers and networks of wetlands to ensure natural processes including upstream connectivity, maintenance of biological diversity, fish migratory routes, free-flowing rivers, and significant water yield areas and water quality.

This indicator is categorized as a Basic level indicator. Decision makers could use this indicator to assess the direct and indirect impacts of natural or artificial barriers on waterways throughout California. Many databases of California roads and streams exist from various sources. Additional data on dams and other structures with impacts on fish passage are available through the CDFW PAD.

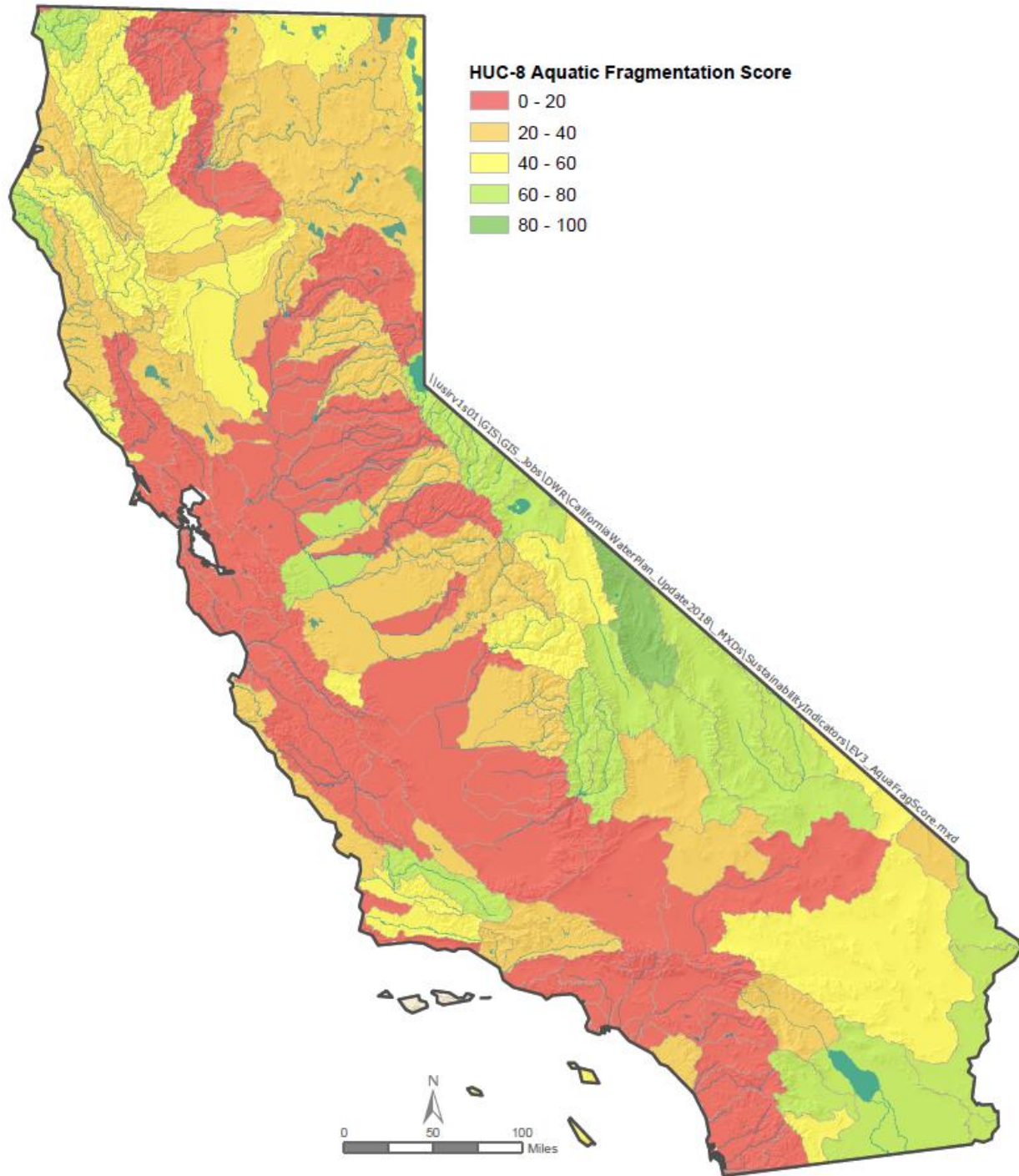
Representative of Outcome:	High
Data Viability:	High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

The initial data used to calculate aquatic fragmentation were a road network of California distributed through the Topologically Integrated Geographic Encoding and Referencing (TIGER) database from the

U.S. Census Bureau. Additional data from CalTrans and the U.S. Forest Service were also incorporated. NHD was used to provide watershed boundaries and the stream data. In addition, dam locations were provided by PAD and moved to intersect with the nearest stream provided by the NHD dataset. However, these data require manual inspection to determine the accuracy of this spatial analysis and, therefore, are not included in the results presented below.

The number of road and stream intersections, as well as an approximation of the number of on-stream dams, was calculated for each watershed. The length of stream was also determined for each watershed. The density of road-stream intersections was calculated for each watershed. For each watershed, this density was then converted into a degree of aquatic fragmentation score. A density of road/stream intersections and dams of 0 crossings/square kilometer (km^2) of stream per watershed was given a score of 100. A literature review conducted in the *California Water Sustainability Indicators Framework: Assessment at State and Regional Scale* final report suggests a value of 0.6 crossings/ km^2 to represent a “high pressure” on aquatic biodiversity. This level of fragmentation was assigned a score of 0. These initial results are shown in Figure 4-14.



Sources: TIGER Products, U.S. Census Bureau
National Hydrologic Dataset, U.S. Geologic Survey
CalTrans GIS Data, CalTrans
National Forest System Roads, U.S. Forest Service

Figure 4-14. Degree of Aquatic Fragmentation

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator continue to develop.

The initial methodology for assessing the degree of aquatic fragmentation throughout California's watersheds, following the approach proposed in the *California Water Sustainability Indicators Framework: Assessment at State and Regional Scale* final report, did not consider that bridges or causeways spanning the entire floodplain of a stream would limiting the impact of road crossings. A methodology to account for road crossings that do not represent a barrier, due to the mitigating effects of a crossing's design, should be developed for this indicator.

Incorporation of PAD data would allow this indicator to represent additional types of barriers that contribute to aquatic fragmentation. The methodology to account for these barriers should include manual verification of a large sample size to estimate the accuracy of the spatial analysis method used during the development of this indicator's current methodology.

In addition, impacts from aquatic fragmentation are felt both upstream and downstream of watershed boundaries. Therefore, this indicator is a general proxy for this impact on ecosystem health and should be considered in conjunction with other indicators, such as *EV 6: California Stream Condition Index*, for a more complete analysis of ecosystem health on upstream and downstream watersheds.

References

Shilling, Fraser. 2014. California Water Sustainability Indicators Framework: Assessment at State and Regional Scale. Final Report. California Department of Water Resources. Prepared by: Department of Environmental Science and Policy at University of California, Davis. Viewed online at: <https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/What-We-Do/Sustainability/Files/Publications/California-Water-Sustainability-Indicators-FrameworkAssessment-at-State-and-Region-Scales--Final-Rep.pdf>

California Department of Fish and Wildlife. "Passage Assessment Database (PAD)." Viewed online at: <https://nrm.dfg.ca.gov/PAD/>. Last accessed: December 12, 2017.

U.S. Census Bureau. "TIGER Products." Viewed online at: <https://www.census.gov/geo/maps-data/data/tiger.html>. Last accessed: December 12, 2017.

U.S. Department of the Interior, U.S. Geologic Survey. "Hydrography." Viewed online at: <https://nhd.usgs.gov/>. Last accessed: December 12, 2017.

California Department of Transportation. "CalTrans GIS Data." Viewed online at: <http://www.dot.ca.gov/hq/tsip/gis/datalibrary/>. Last accessed: December 12, 2017.

U.S. Department of Agriculture, U.S. Forest Service. "Download National Datasets." U.S. Department of Agriculture. Viewed online at: <https://data.fs.usda.gov/geodata/edw/datasets.php>. Last accessed: December 12, 2017.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

EV 5: Impaired Water Bodies – by Hydrologic Region

This indicator assesses the number of impaired water bodies for constituents of aquatic concern on a watershed scale. This is representative of not only the degree of impairment, visible at a statewide scale under *EV 7: Impaired Water Bodies – Count by Watershed*, but also the constituents of concern for each individual watershed, which vary across the state.

Listing a water body as impaired within California’s Integrated Report (Clean Water Act Section 303(d) List / 305 (b) Report) is governed by the Water Quality Control Policy of California’s Clean Water Act Section 303(d) Listing Policy. For each water body on the list, the State identifies the pollutant causing the impairment, when known. The State and Regional Water Boards assess water quality data for California’s waters every two years to determine if they contain pollutants at levels that exceed protective water quality criteria and standards.

The target outcome for this indicator is to have no impaired water bodies on the Clean Water Act Section 303(d) List.

Scale:	Regional
Data Sources:	State Water Board 2014/2016 California Integrated Report (Clean Water Act Section 303(d) List / 305 (b) Report)
Data Availability:	Type I
Metric:	Number of impaired water bodies, pollutants
Screening Status:	Watershed

Importance and Screening Considerations

An increasing population across the state has resulted in increased runoff of agricultural, industrial, and urban pollutants to both surface and ground water. Increased agricultural and urban wastewater discharges, changes in commercial practices and recreational activities, changes in temperature and precipitation patterns caused by climate change, changes in the timing of river flows, as well as other causes have altered water quality and negatively impacted many of California’s ecosystems. Analyzing the types of pollutants with the highest impacts in the 10 hydrologic regions statewide may help focus future ecosystem improvement efforts. For example, watersheds with significant agricultural land acreage, such as those in the Central Valley, may have different constituents of concern than watersheds located in the San Francisco Bay Area (Bay Area).

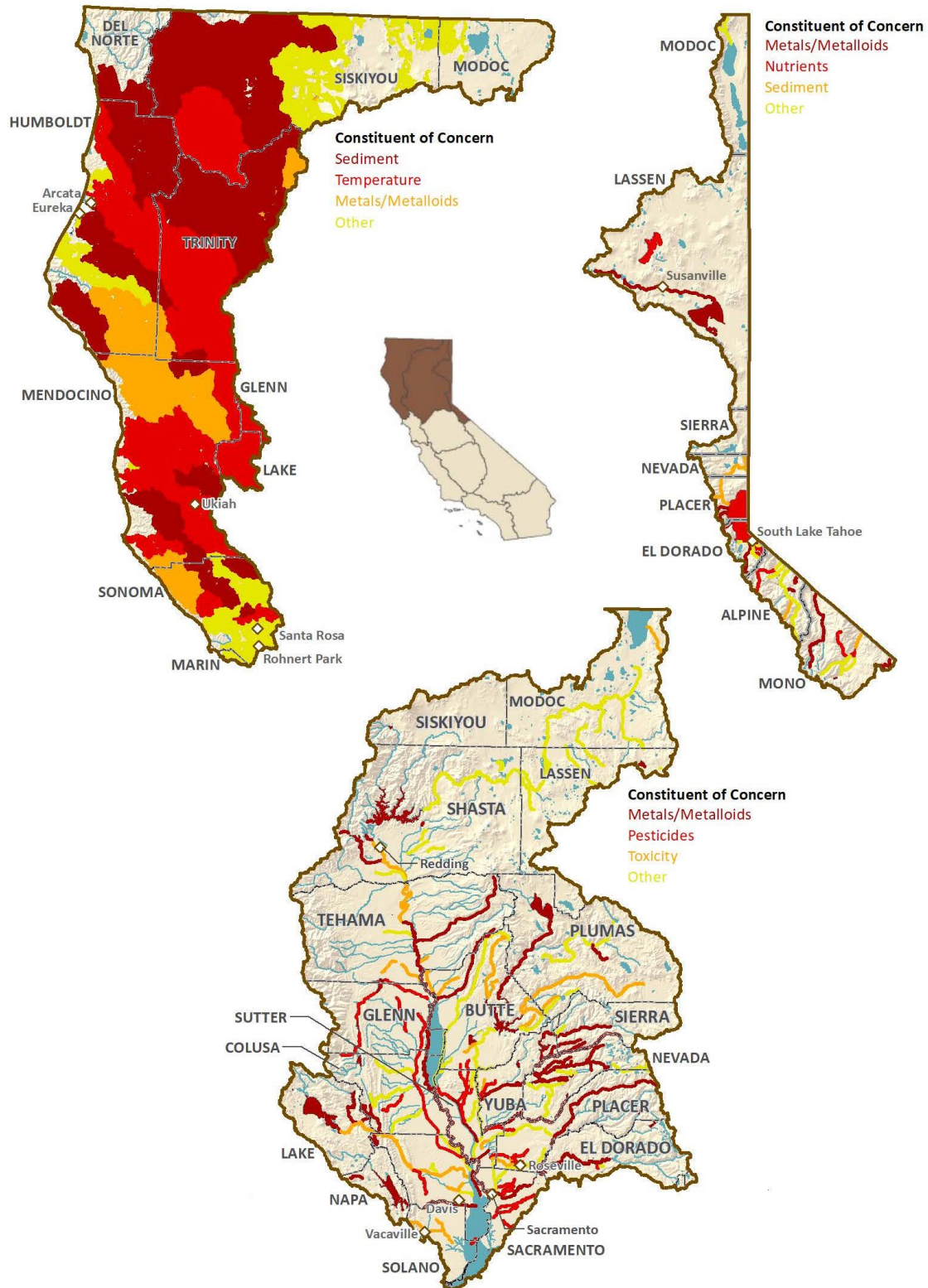
This indicator is considered Watershed level. The number of impaired water bodies throughout California are usually indicative of the overall ecological health of each watershed, however a cause of impairment may not directly impact ecologic health. Data on impaired water bodies are already collected and reported by the State Water Board, and therefore are readily available. The methodology for this indicator involves assessing both the number of impaired water bodies and their common constituents of concern. Identification of the trends would allow decision makers to recognize and prioritize actions on common pollutants in the state.

Representative of Outcome:	Medium
Data Viability:	High
Cost:	High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

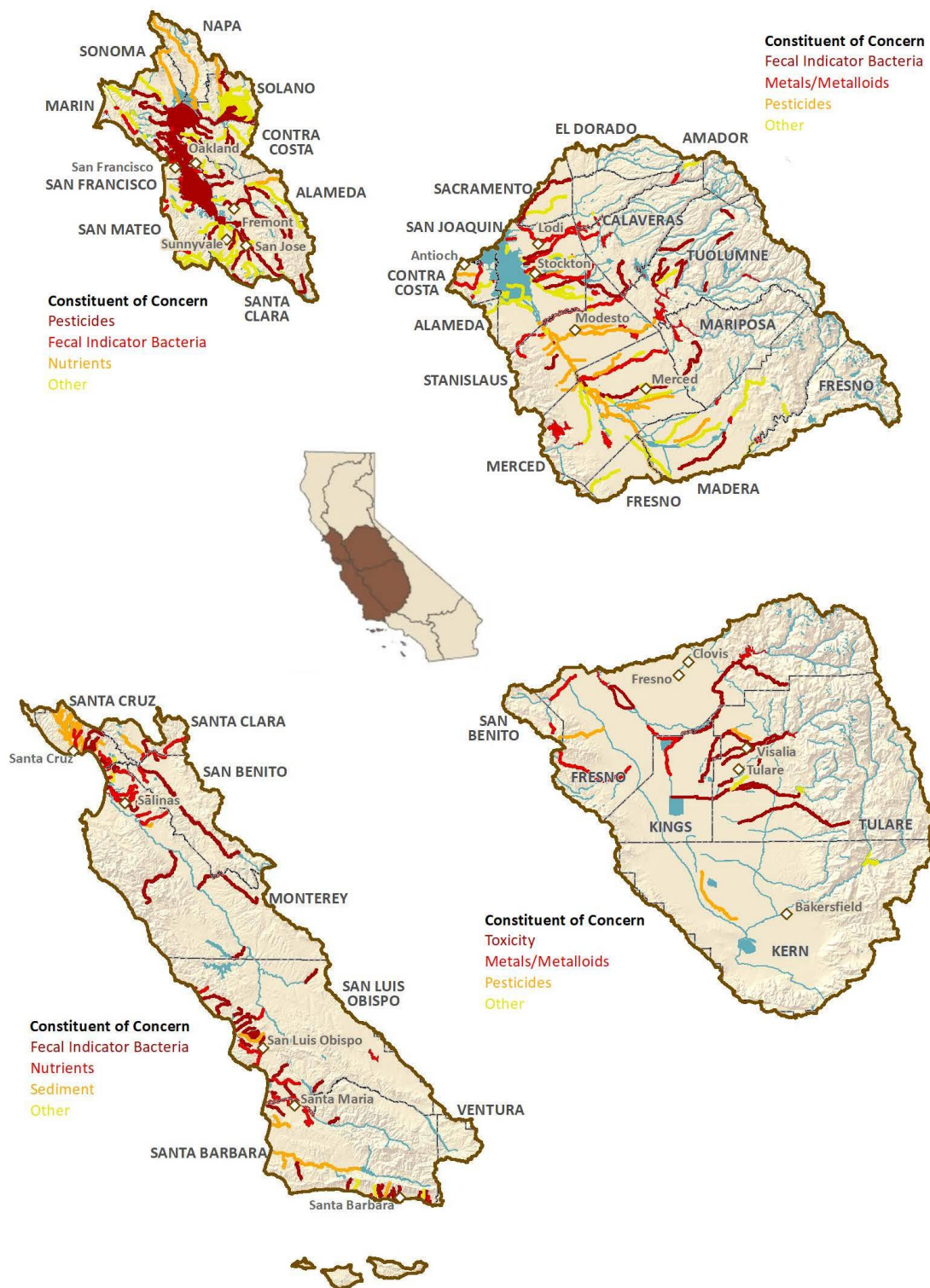
The water bodies on the Clean Water Act Section 303(d) List are updated regularly, approximately every two years. The 2014/2016 California Integrated Report's list was used to produce Figures 4-15 through 4-17. The 2018 California Integrated Report listing process was begun November 3, 2016 with a Notice of Public Solicitation for water quality data and information. When the Clean Water Act Section 303(d) List is approved by the U.S. Environmental Protection Agency (U.S. EPA), GIS files are provided showing all impaired water bodies. These GIS files, along with information on the pollutants causing impairment in each water body, were used to analyze each of ten hydrologic regions for their top constituents of concern. These ten hydrologic regions represent major Californian watersheds.

The top causes of impairment are fairly consistent throughout the state and include contaminants within the fecal indicator bacteria, metals/metalloids, and pesticide categories. In eight of the ten hydrologic regions, metals/metalloids are in the top three causes of impairment. The specific contaminant changes by hydrologic region. Six of the ten hydrologic regions, concentrated in the Central Valley, have water bodies impaired due to pesticides. Fecal indicator bacteria occur in more heavily urbanized areas of the state, including the South Coast and San Francisco Bay hydrologic regions.



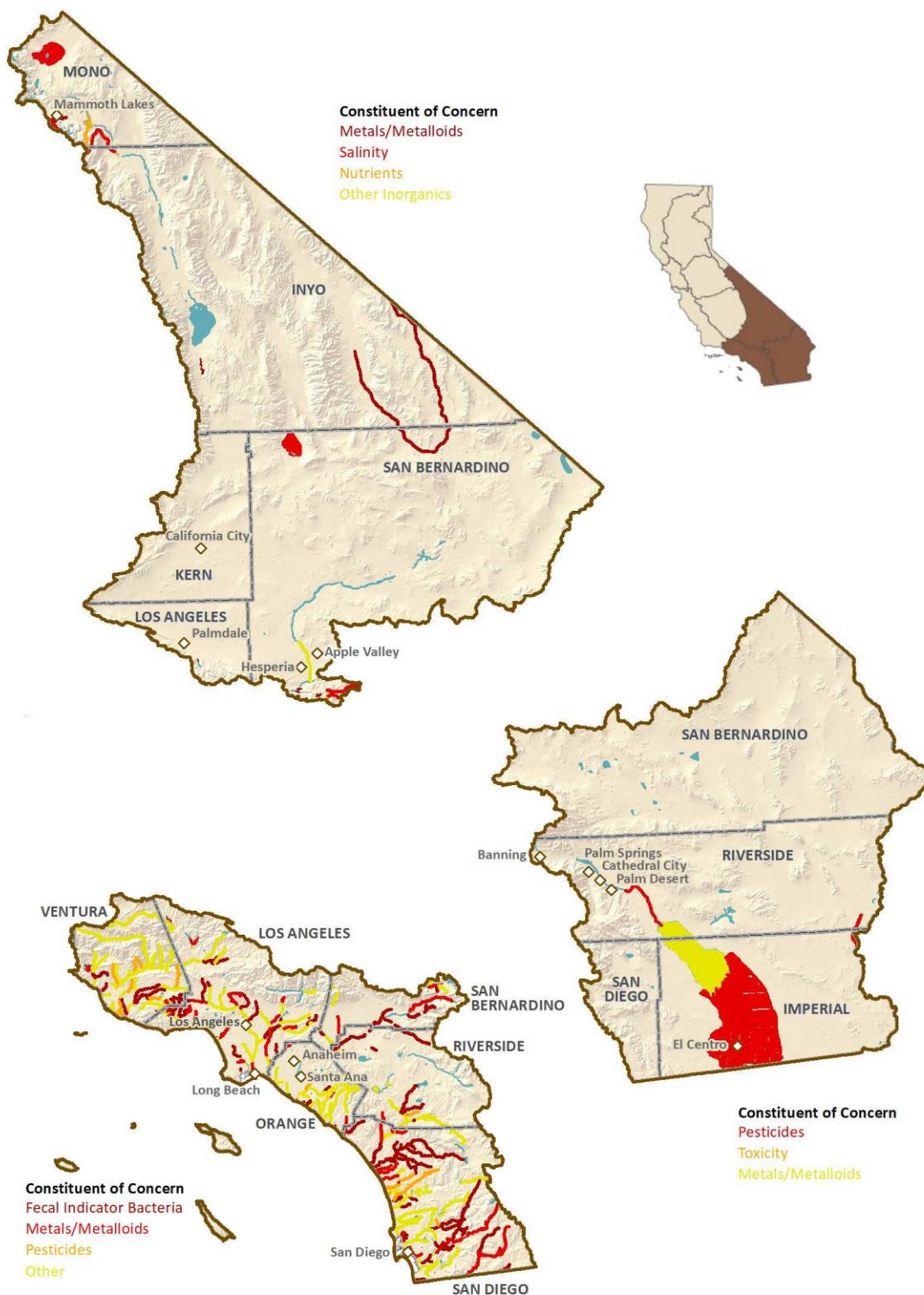
Source: "Impaired Water Bodies – 2014/2016 Integrated Report Approval Documents." State Water Resources Control Board. April 11, 2018.

Figure 4-15. Impaired Water Bodies in the North Coast, North Lahontan, and Sacramento Hydrologic Regions



Source: "Impaired Water Bodies – 2014/2016 Integrated Report Approval Documents." State Water Resources Control Board. April 11, 2018.

Figure 4-16. Impaired Water Bodies in the Bay Area, San Joaquin, Central Coast, and Tulare Lake Hydrologic Regions



Source: "Impaired Water Bodies – 2014/2016 Integrated Report Approval Documents." State Water Resources Control Board. April 11, 2018.

Figure 4-17. Impaired Water Bodies for the South Lahontan, South Coast, and Colorado River Hydrologic Regions

Recommendations

This indicator is a Watershed level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

The process for listing water bodies is well established in California. Updates should continue to be completed regularly to maintain an up-to-date database of impaired water bodies. The GIS representations of the impaired water bodies are planned to be updated in future listing cycles. The GIS-based data should incorporate information on the impaired purpose within the GIS. This would allow this indicator to identify only water bodies related to impairment of ecosystem health.

References

State Water Resources Control Board. 2014/2016 Integrated Report Approval Documents.” State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml. Last accessed: April 11, 2018.

U.S. Environmental Protection Agency. “Clean Water Act Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs).” U.S. EPA. Viewed online at: <https://www.epa.gov/tmdl>. Last accessed: November 28, 2017.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

EV 6: California Stream Condition Index

This indicator assesses the California Stream Condition Index (CSCI), which is a bioassessment index used by various entities to measure the presence and abundance of aquatic plants and animals, providing an indication of waterway and landscape disturbance, geomorphic conditions, appropriate water availability, and water quality. This indicator is adapted from the *California Water Sustainability Indicators Framework: Assessment at State and Regional Scale* final report, published within the CWP Update 2013 materials.

The State Water Board developed the CSCI as a regulatory and informational tool to measure and protect water quality and stream processes. The State Water Board adopted the CSCI as a defensible and useful indicator of water quality and stream disturbance. The index was developed using a large, representative dataset and covers a broad range of environmental variability among natural stream types across California. The CSCI evaluates stream and watershed conditions based on the composition of benthic macro-invertebrate communities relative to the expected composition. The index is composed of two metrics: (1) the ratio of observed to expected taxonomic groups, and (2) the proportion of the assemblage falling into different functional groups that represent species diversity, ecosystem function, and sensitivity to stress.

The target outcome associated with this indicator is a high index score, indicating a stream's ability to support native species and natural processes. The desired condition for this indicator is the mean of the referenced condition (CSCI value = 1.01). Conversely, the undesired condition is the absence of any expected natural benthic macroinvertebrate species (CSCI value = 0).

Scale:	Statewide
Data Sources:	State Water Board Surface Water Ambient Monitoring Program (SWAMP); CWP Update 2013
Data Availability:	Type I
Metric:	California Stream Condition Index
Screening Status:	Basic

Importance and Screening Considerations

The presence and abundance of aquatic plants and animals provide an indication of waterway and landscape disturbance, geomorphic conditions, water availability, and water quality. Biomonitoring has the ability to provide information about past or episodic pollution and the cumulative effects on watersheds. The CSCI provides a direct indicator of the ability of a stream to support wildlife.

Through screening, this indicator is considered a Basic level indicator. The CSCI has been used by the CDFW and the State Water Board as a bioindicator of water quality, providing integrated information on toxic chemical concentrations, dissolved oxygen levels, nutrients, and habitat quality. The State Water Board already collects data associated with the CSCI and provides a standardized calculation, providing a

highly viable dataset. The indicator can be easily understood and represented, thereby supporting decision makers.

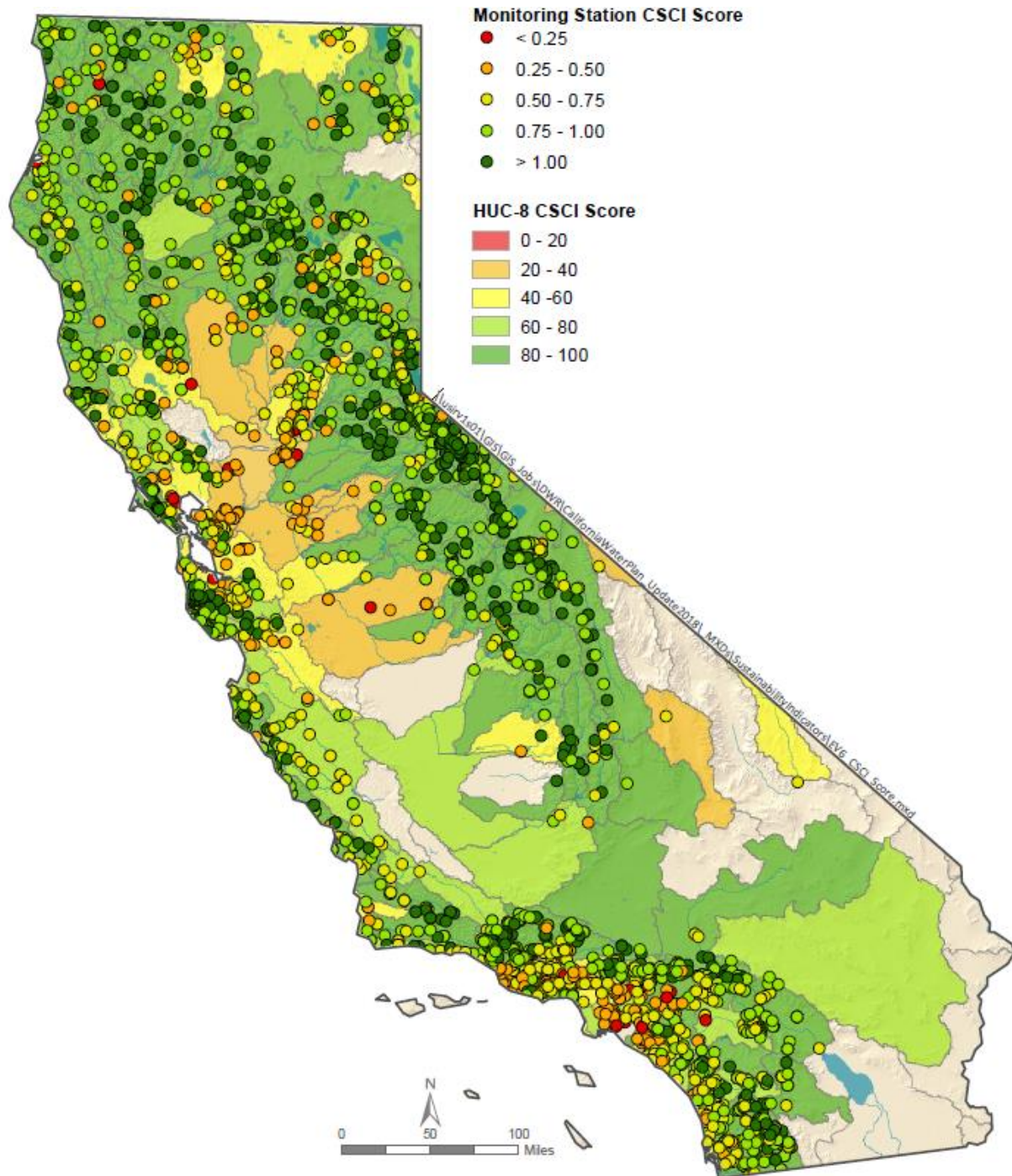
Representative of Outcome:	High
Data Viability:	High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

A database of California Stream Condition Index scores was used, as developed by the State Water Board, to calculate an overall score for each HUC-8 watershed across the state. Data for this indicator were evaluated following the approach established in the *California Water Sustainability Indicators Framework: Assessment at State and Regional Scale* final report. The CSCI for each recorded point in a watershed boundary was averaged for the watershed. Afterwards, each watershed received a score based on this average CSCI value. Any CSCI average above 1.01, received a score of 100 for the watershed. A watershed with an average CSCI score between 0.87 and 1.01, received a proportional score between 90 and 100. Similarly, a watershed with an average CSCI score between 0.72 and 0.87, received a proportional score between 50 and 90. All watersheds with average CSCI scores between 0 and 0.72 received a proportional score between 0 and 50.

Figure 4-18 displays both the average CSCI score across each HUC 8 watershed as well as the individual scores from monitoring stations used to calculate this HUC 8 score. Watersheds with no available monitoring station scores are unshaded. As shown, Central Valley watersheds, especially in and near the Delta have lower scores. However, these scores are based on fewer monitoring stations than the average scores of watersheds in the Sierra Nevada, in southern California, and south of the Bay Area. The degree to which conditions at isolated sites reflect upstream conditions depends on the size and natural processes of the upstream watershed (Shilling 2014).

California's rural undeveloped regions have higher CSCI scores. As visible on this map, monitoring has occurred more heavily in certain regions of the state, including southern California. Future monitoring will rotate through California regions based on funding availability. Therefore, the map shows multiple years of monitoring rather than a single year to provide greater spatial resolution.



Source: Bioassessment Scores Map. State Water Resources Control Board. 2017.

Figure 4-18. California Stream Condition Indices Across California Watersheds

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

The methodology for assessing the CSCI as an indicator provides a quick analysis of stream ecosystem health. Current monitoring should continue both at current monitoring stations and new monitoring stations to improve the current spatial resolution of data points.

References

- Shilling, Fraser. 2014. California Water Sustainability Indicators Framework: Assessment at State and Regional Scale. Final Report. California Department of Water Resources. Prepared by: Department of Environmental Science and Policy at University of California, Davis. Viewed online at: <https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/What-We-Do/Sustainability/Files/Publications/California-Water-Sustainability-Indicators-FrameworkAssessment-at-State-and-Region-Scales--Final-Rep.pdf>
- Rehn, Andrew C, Raphael Mazor, and Peter R Ode. 2015. The California Stream Condition Index (CSCI): A New Statewide Biological Scoring Tool for Assessing the Health of Freshwater Streams. Surface Water Ambient Monitoring Program. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/docs/csci_tech_emo.pdf
- State Water Resources Control Board. "Bioassessment Scores Map." State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/csci_scores_map.shtml. Last accessed: December 1, 2017.

Ecosystem Vitality

Intended Outcome: Achieved designated beneficial uses for water bodies throughout the state

EV 7: Impaired Water Bodies – Count by Watershed

Similar to EV 5, *Impaired Water Bodies – by Hydrologic Region*, this indicator assesses the number of impaired water bodies, but on a statewide scale. The State and Regional Water Boards assess water quality data for California’s waters every two years to determine if they contain pollutants at levels that exceed protective water quality criteria and standards. A complete listing of impaired water bodies throughout the state can be found within California’s Integrated Report (Clean Water Act Section 303(d) List / 305 (b) Report).

The target condition for this indicator is that zero percent of water bodies in the state are listed on the Clean Water Act Section 303(d) List, indicating that water bodies are not impaired and therefore, are able to support a healthy and thriving ecosystem.

Scale:	Statewide
Data Sources:	State Water Board 2014/2016 California Integrated Report (Clean Water Act Section 303(d) List / 305 (b) Report); U.S. Geological Survey (NHD
Data Availability:	Type I
Metric:	Percentage of water bodies on Clean Water Act Section 303(d) List
Screening Status:	Basic

Importance and Screening Considerations

An ever increasing population across the state has resulted in increased runoff of agricultural, industrial and urban pollutants to both surface and ground water. In addition, increased agricultural and urban wastewater discharges, changes in commercial practices and recreational activities, changes in temperature and precipitation patterns caused by climate change, changes in the timing of river flows, as well as other causes have altered water quality and have negatively impacted many of California’s ecosystems. An indicator that assesses the number of impaired water bodies for constituents of aquatic concern represents how those identified stressors may be impacting California’s ecosystems in each watershed.

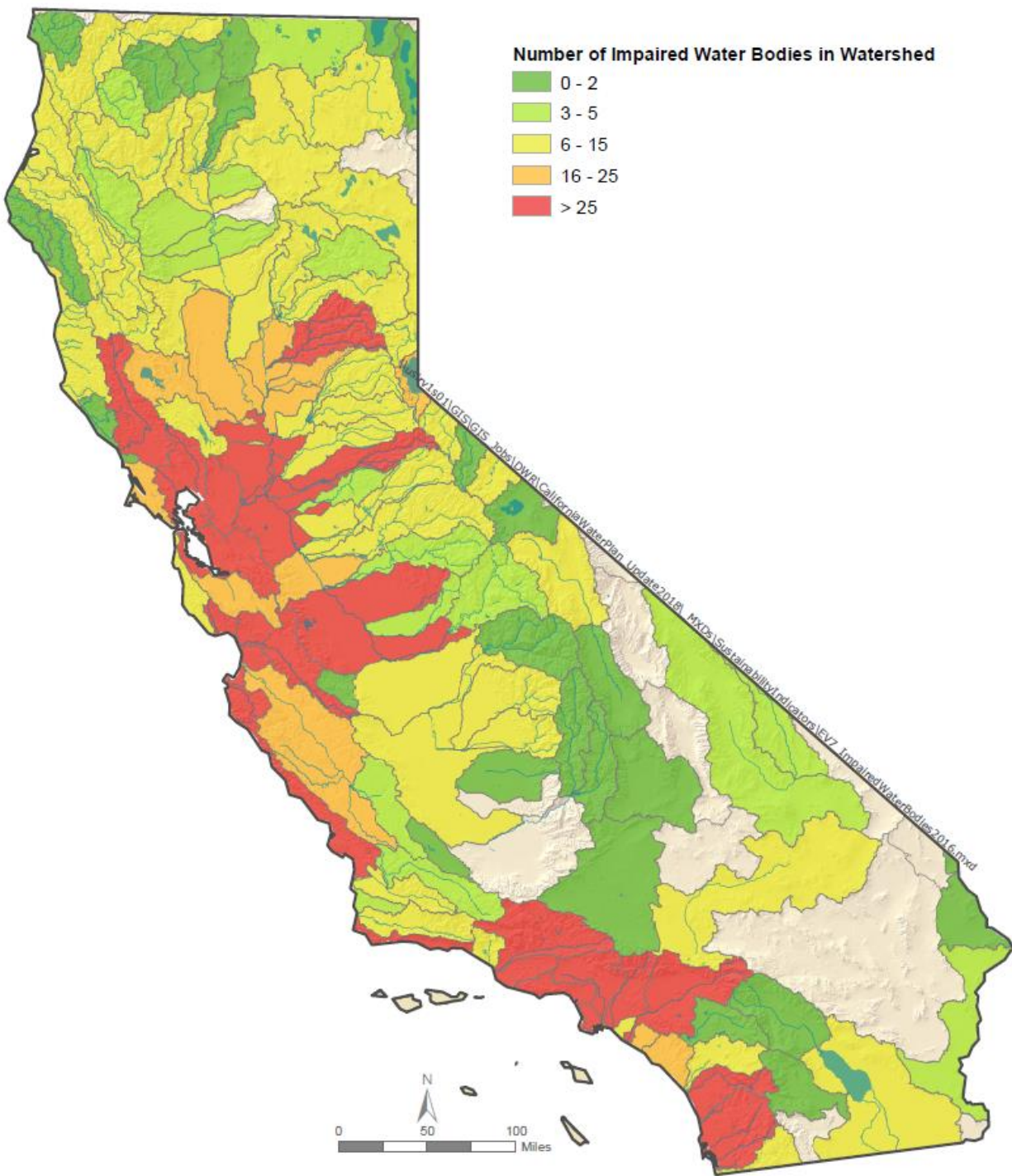
This indicator is considered a Basic level indicator as a result of the screening process. The number of impaired water bodies throughout California’s watersheds can be indicative of the overall ecological health of California watersheds. Although overlap with other indicators exist, the individual assessments are unique. For example, assessing the number of impaired water bodies on a statewide scale could highlight the correlation between agriculture and the prevalence of impaired water bodies. Data on impaired water bodies are already collected by the State Water Board, so would be readily available and relatively easy to collect at a statewide level.

Representative of Outcome:	Medium-High
Data Viability:	High
Cost:	Low
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

The water bodies on the Clean Water Act Section 303(d) List are updated regularly, approximately every two years. The 2014/2016 California Integrated Report was used to produce Figure 4-19. The 2018 California Integrated Report listing process was begun November 3, 2016 with a Notice of Public Solicitation for water quality data and information. When the Clean Water Act Section 303(d) List is approved by the U.S. EPA, GIS files are provided showing all impaired water bodies. These GIS files were used to analyze the percent of impaired water bodies by watershed. The total number of water bodies used for this indicator was drawn from the U.S. Geological Survey NHD. The analysis considers the impaired area or length in a watershed compared to the impaired area or length in a watershed, respectively. This analysis does not account for watersheds with fewer overall water bodies or for watersheds with fewer individual impaired water bodies listed, but a higher length and surface area of water bodies. Urban areas have a higher number of impaired water bodies.

As can be seen in Figure 4-19, urban centers in California, including areas in and near San Francisco, Los Angeles, and San Diego, have the highest number of impaired water bodies by watershed. Coastal areas also have a high degree of impairment.



Source: "Impaired Water Bodies – 2014/2016 Integrated Report Approval Documents." State Water Resources Control Board. April 11, 2018.

Figure 4-19. Number of Impaired Water Bodies by Watershed

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. Future work on this indicator should narrow the analysis to water bodies impaired specifically for ecosystem-related purposes.

The process for listing water bodies is well established in California. Updates should continue to be completed regularly to maintain an up-to-date database of impaired water bodies. The GIS representations of the impaired water bodies are planned to be updated in future listing cycles. The GIS-based data should incorporate information on the impaired purpose within the GIS. This would allow this indicator to identify only water bodies related to impairment of ecosystem health.

References

State Water Resources Control Board. 2014/2016 Integrated Report Approval Documents.” State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml. Last accessed: April 11, 2018.

U.S. Environmental Protection Agency. “Clean Water Act Section 303(d): Impaired Waters and Total Maximum Daily Loads (TMDLs).” U.S. EPA. Viewed online at: <https://www.epa.gov/tmdl>. Last accessed: November 28, 2017.

Ecosystem Vitality

Intended Outcome: Achieved designated beneficial uses for water bodies throughout the state

EV 8: Number of Harmful Algae Blooms

This indicator surveys the number of harmful algae blooms that occur throughout California. Although this indicator is focused on ecosystem vitality, contact exposure warning information has also been collected to help determine potential effects on public health and safety.

A positive outcome of this sustainability indicator is a decreasing trend overtime in the number of harmful algae blooms in coastal and inland water bodies. The target outcome for this indicator is for no harmful algae blooms to occur throughout the state. From a public health and safety perspective, all individual harmful algae blooms should be associated with a public contact exposure warning.

Scale:	Statewide
Data Sources:	State Water Board SWAMP; State Water Board BeachWatch
Data Availability:	Type I
Metric:	Number of reported contact exposure warnings issued
Screening Status:	Basic

Importance and Screening Considerations

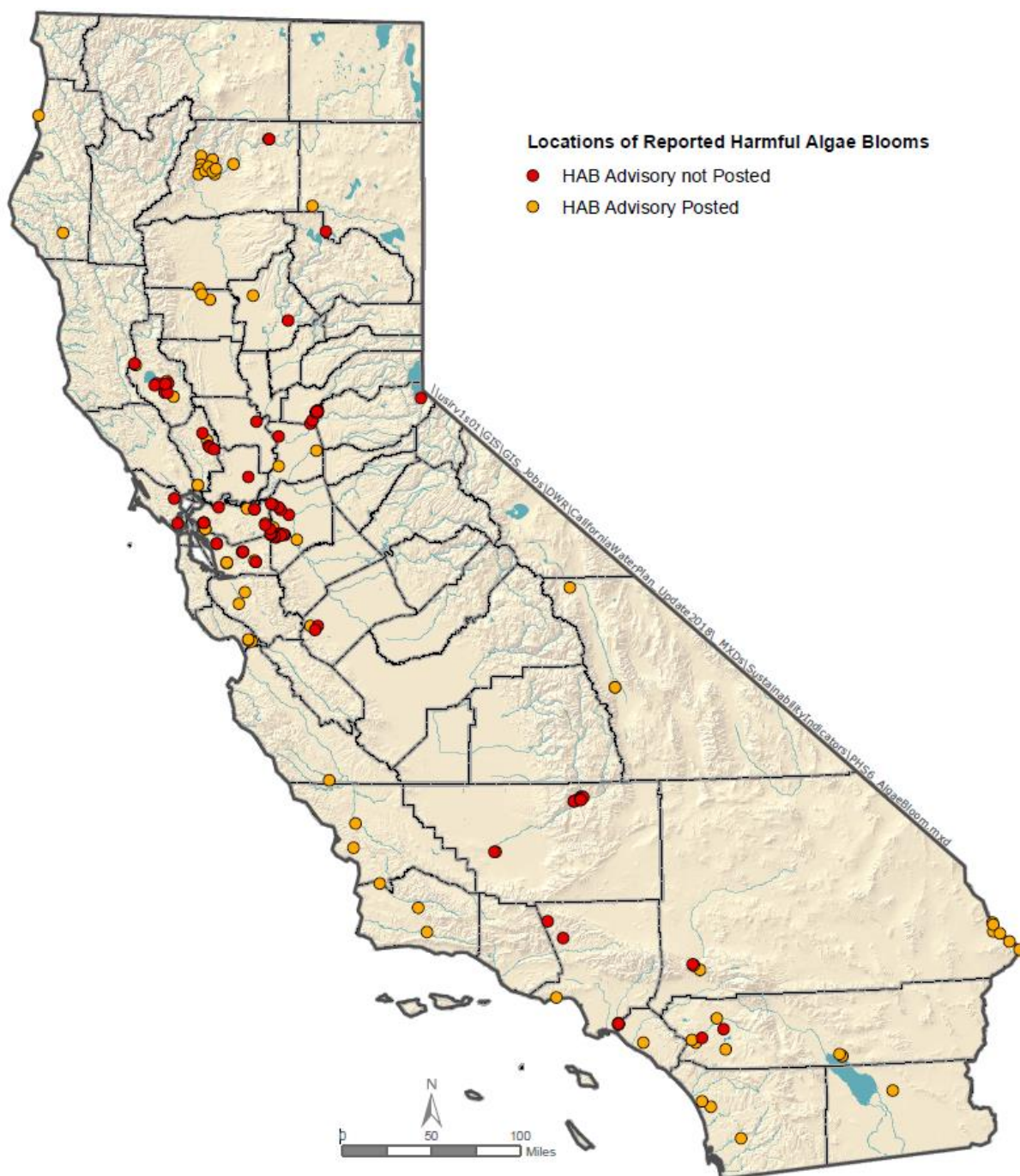
Harmful algae blooms can often be directly correlated to poor water quality, a direct threat to the beneficial use of water. The number of harmful algae blooms, especially repeated incidents in the same water body, may indicate water quality issues that need to be addressed. Issuing contact exposure warnings when harmful algae and bacteria are present in water bodies throughout California can protect the public from water borne illnesses and other hazards associated with poor water quality.

This indicator is categorized as a Basic level indicator. Data on contact exposure warnings issued due to freshwater harmful algae blooms are voluntarily reported to the State Water Board SWAMP. In addition, data on algae blooms are collected at six sites along the California coast. These data are adaptable and easy to understand at regional, state, and local levels, making this indicator supportive of decision making.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Medium – High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Initial data on past harmful algae blooms are presented in Figure 4-20. These data were collected by the State Water Board SWAMP and reported through the California Water Quality Monitoring Council's Harmful Algal Blooms Portal. Information on coastal algae blooms is not included in this analysis due to a lack of access to a centralized database. While some harmful algae blooms result in a posted warning, many reported blooms have no posted signs to alert potential visitors. Although warnings may not be posted at certain locations, some of the harmful algae blooms are located on private lands, where posted warning signs may not be feasible or necessary. In addition, notifications to nearby residents may be sent out instead of posted signs. At several locations, such as Lake Shasta in northern California, algae blooms recur frequently, offering potential to implement prevention policies.



Source: "Where are harmful algal blooms occurring in California?" California Water Quality Monitoring Council. February 6, 2018.

Figure 4-20. Contact Exposure Warnings Issued for Harmful Algae Blooms

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. Mitigating the causes of harmful algae blooms are critical to ecosystem vitality in water bodies with repeated blooms. Currently available centralized datasets only include

voluntary reporting of harmful algae blooms and responses for freshwater bodies. Additional data should be collected to consistently capture information on both harmful algae blooms and contact exposure warning occurrences across all water bodies in the state. A mandatory reporting program, with funding, could be instated, replacing the current voluntary reporting to SWAMP. Such a program should be expanded to include coastal waters in addition to freshwater harmful algae blooms. New methods to identify the number of harmful algae and bacteria blooms, including crowd-based reporting methods, should be integrated into existing databases as appropriate.

References

California Water Quality Monitoring Council. “Where are harmful algal blooms occurring in California?” My Water Quality. Viewed online at:
http://www.mywaterquality.ca.gov/habs/where/freshwater_events.html. Last accessed: February 6, 2018.

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply.

HE 1: Delivery Reliability of SWP, CVP, Colorado River Aqueduct Systems

This composite indicator assesses the water supply reliability of the following systems: the California State Water Project (SWP), the federal Central Valley Project (CVP), and the Colorado River Aqueduct. For the purposes of this indicator, reliability is defined as each system's ability to meet contracted or promised water supply allocations on an annual basis.

Scale:	Statewide
Data Sources:	DWR; U.S. Department of the Interior, Bureau of Reclamation (Reclamation)
Data Availability:	Type I
Metric:	Percent difference of actual water deliveries to long term average
Screening Status:	Basic (Future)

Importance and Screening Considerations

The SWP, CVP, and Colorado River Aqueduct are important water supply systems that continue to provide many areas of California with agricultural and municipal water supplies. However, each system's ability to supply water may be affected by extreme hydrologic conditions.

Operated by Reclamation, the CVP extends from the Cascade Range in the north to the plains along the Kern River in the south. Initial features of the federal project were built to provide flood protection for the Central Valley and supply domestic and industrial water in the valley. The CVP also improves Sacramento River navigation, generates electric power, conserves fish and wildlife, creates opportunities for recreation, and helps address some water quality issues.

Similar to the CVP, the SWP is a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. Its main purpose is to store and distribute contracted water supplies with 70 percent going to urban users and 30 percent going to agricultural users. Many communities are reliant on the water supplies they receive from this State-owned operation.

The 242-mile Colorado River Aqueduct provided the water that made the large-scale population and economic growth of Southern California possible in the second half of the 20th century. The aqueduct stretches 242 miles from the Colorado River on the California-Arizona border to its final holding reservoir in Southern California. The Metropolitan Water District of Southern California operates the Colorado River Aqueduct.

CVP water irrigates more than 3 million acres of farmland and provides drinking water to nearly 2 million consumers. SWP water meets the needs of 20 million Californians and irrigates more than 600,000 acres. Southern California continues to rely on water supplies from the Colorado River Aqueduct. Water supplies from these systems are particularly important for supporting one of California's most valued economic resources - agriculture. In 2016, California's farms and ranches received approximately \$45.3

billion for their output, and California remains the leading U.S. state in cash farm receipts. Over a third of the country's vegetables and two-thirds of the country's fruits and nuts are grown in California.

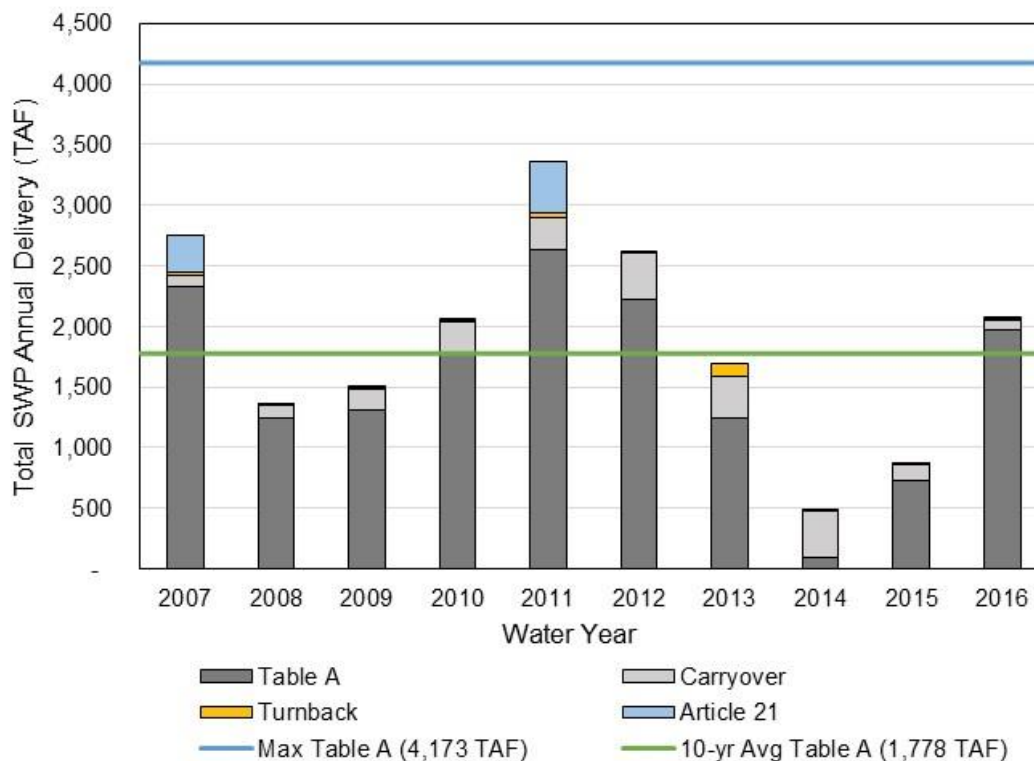
Currently, there are no initial data sources identified for assessing the reliability of the Colorado River Aqueduct, but DWR releases a SWP Delivery Capability Report and Reclamation provides CVP contract water delivery information annually. Therefore, this indicator is considered Basic (Future) during the initial screening process. Once a data source is identified for the Colorado River Aqueduct, a complete analysis of this composite indicator may be performed.

This indicator will be more applicable on a regional scale because deliveries from the SWP, CVP, and Colorado River Aqueduct only cover a portion of California's water supply systems. Although the SWP makes deliveries to two-thirds of California's population and the CVP delivers enough water to supply about 2.5 million people for a year, this indicator may not be as relevant in some regions, especially those that do not have a strong reliance on water supplies from the SWP, CVP, or Colorado River Aqueduct, such as the northern coastal area.

Representative of Outcome:	Low-Medium
Data Viability:	High
Cost:	Low-Medium
Potential Longevity:	High
Supportive of Decision Making:	Low-Medium

Initial Data and Results

SWP Contractor deliveries are presented as four different delivery types in the SWP Delivery Capability Report: Table A delivery, Article 21 delivery, carryover delivery, or turn back delivery. Figure 4-21 shows that deliveries of SWP Table A water for 2007 – 2016 range from an annual minimum of 475 thousand acre-feet (TAF) to a maximum of 2,901 TAF, with an average of 1,778 TAF. Historical deliveries of SWP Table A water over this 10-year period are less than the maximum of 4,173 TAF/year. Total annual historical SWP deliveries, including Table A, Article 21, turnback pool, and carryover water, range from 477 to 3,352 to 477 TAF over the 10-year period.



Source: 2017 State Water Project Draft Delivery Capability Report. California Department of Water Resources. 2017.
Figure 4-21. Total Historical State Water Project Deliveries, 2007 – 2016 (by Delivery Type)

Table 4-9 provides the percent change from the long-term 10-year average Table A Deliveries from 2007 to 2016. The long-term average is 1,778 TAF. Of the 10 years, only 4 years have delivered Table A supply above the 10-year long-term average.

Table 4-9. Percent Change of Annual State Water Project Table A Deliveries from Long-term 10-year Average Table A Deliveries (2007 to 2016)

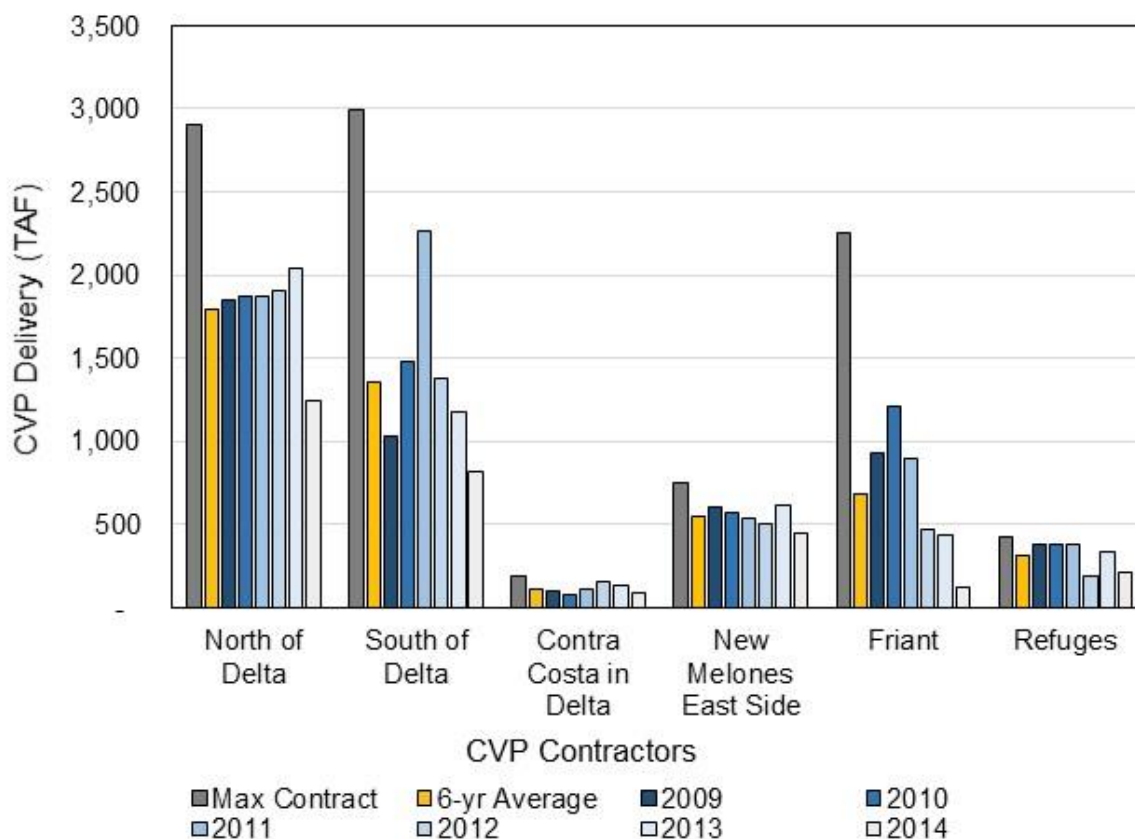
Year	Table A Delivery (TAF)	Percent Change from Long-term 10-year Average Table A Deliveries (1,778 TAF)
2007	2,332	31.2%
2008	1,246	-29.9%
2009	1,308	-26.4%
2010	1,774	-0.2%
2011	2,633	48.1%
2012	2,227	25.3%
2013	1,238	-30.4%
2014	92	-94.8%
2015	725	-59.2%
2016	1,976	11.1%

Source: 2017 State Water Project Draft Delivery Capability Report. California Department of Water Resources.

Key:

TAF = thousand acre-feet

Similar to the SWP Delivery Capability Report, the CVP provides historical contract water delivery information by water year. CVP water contractors include those North-of-Delta, South-of-Delta, Contra Costa Water District in the Delta, New Melones East Side, Friant, and Refuges. Figure 4-22 and Table 4-10 below provide the actual water deliveries for water years 2009-2014, as well as the maximum contract and long-term 6-year average of actual deliveries from 2009-2014 for each grouping. In general, water year 2014 deliveries were well below the 6-year average of CVP deliveries for all water contractors. A similar trend was detected in SWP delivery data (presented above). This trend is evidence that CVP and SWP reliability are dependent on hydrologic conditions.



Source: 2015 Central Valley Contract Water Delivery Information. U.S. Department of the Interior, Bureau of Reclamation.

Notes:

Deliveries to Friant and South of Delta agricultural contractors in 2014 was rescheduled water from 2013.

Delivery data to refuges are direct deliveries from Reclamation. Refuge deliveries accomplished through transfers or substitutions are included in delivery amounts of contractor that made the transfer.

Figure 4-22. Historical Central Valley Project Deliveries, 2009 – 2014

Table 4-10. Percent Change from Annual CVP Contract Deliveries to the Long-term 6-year Average CVP Contract Deliveries from 2009 to 2014.

Percent Change from Long Term 6-year Average of Actual Deliveries						
Year	North of Delta	South of Delta	Contra Costa Water District in Delta	New Melones East Side	Friant	Refuges
Max Contract (TAF)	2,898	2,989	195	755	2,249	422
6-yr Average (TAF)	1,799	1,359	113	546	678	312
2009	3%	-24%	-11%	10%	37%	23%
2010	4%	9%	-35%	5%	79%	21%
2011	4%	67%	-2%	-2%	33%	22%
2012	6%	1%	42%	-9%	-31%	-39%
2013	13%	-13%	22%	13%	-36%	7%
2014	-31%	-40%	-17%	-17%	-82%	-34%

Source: 2015 Central Valley Contract Water Delivery Information. U.S. Department of the Interior, Bureau of Reclamation.

Notes:

Deliveries to Friant and South of Delta agricultural contractors in 2014 was rescheduled water from 2013. Delivery data to refuges are direct deliveries from Reclamation. Refuge deliveries accomplished through transfers or substitutions are included in delivery amounts of contractor that made the transfer.

Key:

TAF = thousand acre-feet

Recommendations

This indicator is Basic (future) level, so the guidelines and framework will continue to develop based on the existence of more reliable data or methodologies to evaluate the delivery reliability of the SWP, CVP, and the Colorado River Aqueduct.

In the future, an assessment similar to what was performed for the SWP and CVP should be included for the Colorado River Aqueduct. Assessing the long-term average delivery of each system is an appropriate way to represent a reliability trend, as annual maximum contract amounts are rarely met. The owners and operators of the Colorado River Aqueduct should have historical documentation of deliveries and contract amounts, but it would be helpful for that information to be stored in a centralized database or published in an annual report similar to the SWP Delivery Capability Report and the CVP Contract Water Delivery Information.

References

California Department of Water Resources. 2017. The State Water Project Draft Delivery Capability Report 2017. Viewed online at: <https://msb.water.ca.gov/documents/86800/e00836f7-68f5-4f00-aeb8-450dc475436b>

California Department of Water Resources. California State Water Project Overview. Viewed online at: <http://wdl.water.ca.gov/swp/>

California Department of Food and Agriculture. California Department of Food and Agriculture. Viewed online at: <https://www.cdfa.ca.gov/>. Last accessed: February 2, 2018.

U.S. Department of the Interior, Bureau of Reclamation. November 2015. "CVP Contract Water Delivery Information." Viewed online at: <https://www.usbr.gov/mp/cvp-water/docs/cvp-water-deliveries.pdf>. Last Accessed: May 10, 2018.

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply

HE 2: Comparison of Actual Water Use to Proposed Statewide Water Use Targets

This indicator assesses progress toward achieving statewide water use targets by providing a comparison of actual water use to statewide water use targets. AB 1668 and SB 606 have been enacted by the Legislature to codify the policies and authorities for making water conservation a California way of life. These bills amended the California Water Code, requiring state agencies to develop statewide water use targets, standards, and guidelines, and water agencies to then report on progress towards meeting those requirements.

Scale:	Statewide
Data Sources:	SB 606 and AB 1668 (draft language); UWMPs and AWMPs (future data sources)
Data Availability:	Type I
Metric:	Proportion of actual water use to water use targets
Screening Status:	Basic (Future)

Importance and Screening Considerations

As evidenced by recent drought conditions, the need to pursue water use efficiency is important to ensure future water supply reliability statewide and an economical water market. Achieving statewide water use targets will help limit and lower actual water use levels. This indicator could provide evidence of the impact that a statewide focus on water use efficiency has on the overall state water balance.

This indicator is considered a Basic (Future) level indicator. This indicator would be included in future Water Plan updates because the two bills are yet to be enacted, the standards and guidelines are not developed, and data are not available for evaluation. Even when statewide water use goals or targets change, assessing where the state may be over or under water use targets could be useful to decision makers. The data may need to be accessed through multiple entities and resources, which may make data collection standardization difficult.

Representative of Outcome:	Medium-High
Data Viability:	Medium
Cost:	Low-Medium
Potential Longevity:	Medium-High
Supportive of Decision Making:	High

Initial Data and Results

No initial data are presented because legislation is currently being drafted that would provide guidance to evaluate this indicator. The enactment of this legislation is eminent, which is why this indicator is considered Basic (Future) rather than Advanced. A description of the potential methodology to evaluate this indicator and legislation pertaining to water use targets is presented below.

Recommendations

Water Conservation Bill of 2009 SB X7-7 requires the state to achieve a 20 percent reduction in urban per capita water use in California by December 31, 2020. Each urban retail water supplier is required to develop urban water use targets and an interim water use target. The Urban Water Management Planning Act requires every public and private urban water supplier that directly or indirectly provides water for municipal purposes to prepare and adopt an urban water management plan to be updated every 5 years.

For assessing water use targets, the Urban Water Management Planning Act could help provide data and establish framework to evaluate this indicator. UWMPs are prepared by every urban water supplier that either provides over 3,000 acre-feet of water annually, or serves more than 3,000 urban connections. For an UWMP, the water supplier assesses the reliability of its water sources over a 20-year planning horizon and reports progress toward the 20 percent reduction in per-capita urban water consumption by the year 2020 under existing law. AB 1668, when enacted, would require the State Water Board, in coordination with DWR, to adopt long-term standards for the efficient use of water and would establish specified standards for per capita daily indoor residential water use.

Each UWMP is required to include total water demands. However, there is no mandated method for measuring/estimating water use meaning that data may need to be post-processed to allow for comparison of water use amongst UWMPs. The statewide water use target from AB 1668 for per capita water use could be used to compare the actual water use (demand) per capita. The per capita use targets may be different in each hydrologic region due to factors such as climate, land use pattern, population, and socioeconomic distribution.

It would be helpful to visualize the progress towards meeting state water use targets on a map organized by county. However, similar to *PHS 8*, there is no consistency in the service area boundaries for UWMPs. Private and public water agencies develop UWMPs. Some of the UWMPs are for cities while others are for counties and some are even for private water agencies. To display this information on a geo-referenced map in the future, it is recommended that DWR require geospatial map layers of each urban water supplier boundary as part of the next round of UWMP updates. (The *2015 UWMP Guidebook for Urban Water Suppliers* states that DWR's preference is to obtain electronic service area boundary maps.) The following metadata should be included: map projection, contact information for the map's creator, start and end dates for which the map is valid, constraints, attribute table definitions, and a digitizing base. Requiring the geospatial map layer would eliminate the need to manually define the boundary of each UWMP to create a map that would geographically show an area's progress towards meeting statewide water use targets. If no geospatial map layers for UWMP boundaries can be obtained, then analyzing this indicator by hydrologic region, as was done in *PHS 8*, would be sufficient.

SB 606 and AB 1668 establish both the foundation and needed authorities for long-term improvements in water conservation and drought planning to adapt to climate change and the resulting longer and more intense droughts in California. These bills amended the California Water Code, requiring state agencies to develop statewide water use targets, standards, and guidelines, and water agencies to then report on progress towards meeting those requirements. During the implementation process, DWR and other State agencies will further develop data, information, guidelines, and other technical assistance to help realize the bills' intended outcomes. Both bills include requirements for public access to data and their use, as well as related studies, reports, and investigations. These data, studies, reports, and investigations may be of use to continued development of this indicator.

References

California Department of Water Resources. 2016. Guidebook for Urban Water Suppliers- 2015 Urban Water Management Plans. Viewed online at:
http://www.water.ca.gov/urbanwatermanagement/docs/2015/UWMP_Guidebook_Mar_2016_FINAL.pdf

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply

HE 3: Distribution System Leaks and Losses

This indicator assesses water supply distribution system leaks and losses. Leak detection is a necessary component to the management of water distribution systems, because lost water represents lost money and energy expended during treatment and pressurization. The target outcome for this indicator is zero distribution system leaks and losses, indicating no money or energy is wasted following treatment and pressurization of water.

Scale:	Regional
Data Sources:	UWMPs; DWR Water Audit Manual
Data Availability:	Type II
Metric:	Volume of water lost in distribution systems
Screening Status:	Watershed

Importance and Screening Considerations

Recognizing and identifying distribution leaks and losses could help reduce costs to water distribution systems over time. Leaks will invariably get larger with time, so identifying leaks regularly will prevent major economic and water supply losses. Leak detection and repair may also reduce power costs to deliver water and reduce chemical costs to treat water.

Through screening, this indicator was identified as a Watershed level indicator. Assessing distribution leaks and losses is more applicable to urban areas and developed systems. The DWR Water Use Efficiency guidelines and data on Water Audit and Leak Detection provide viable data to represent this indicator.

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Initial data on water loss volumes were derived from 2015 UWMPs. As shown in Table 4-11, regions with the highest water losses represent urbanized areas of the state. The South Coast (Los Angeles), San Francisco Bay (Bay Area), and Sacramento River (Sacramento area) hydrologic regions have the highest quantity of reported water losses. Losses are not reported by all wholesale suppliers, but are required from urban water suppliers.

Table 4-11 also notes the losses that have undergone review by DWR, as part of the broader UWMP documentation.

Table 4-11. Water Losses Reported by Hydrologic Region for Urban Water Supplies over 12 Months

Hydrologic Regions	No		Under Review		Yes		Total AF
	AF	%	AF	%	AF	%	
South Coast	10,710	6%	42,142	24%	124,924	70%	177,776
San Francisco Bay	7,553	10%	9,349	12%	59,836	78%	76,738
Sacramento River			13,979	31%	31,230	69%	45,209
Tulare Lake			1,865	6%	30,089	94%	31,954
San Joaquin River	143	1%	8,101	37%	13,867	63%	22,112
Colorado River	1,031	5%	2,391	12%	16,347	83%	19,769
South Lahontan	4,862	42%	2,035	18%	4,633	40%	11,530
Central Coast			1,660	15%	9,789	85%	11,450
North Coast			2,793	50%	2,774	50%	5,567
North Lahontan	687	26%	276	11%	1,634	63%	2,598

Source: Water Use Efficiency Data Public Portal. January 10, 2018.

Key:

AF = acre-feet

Recommendations

This indicator is most applicable to urban regions. A geographic representation of the spread of data may be possible if system locations are required as part of standard data collection.

Future development of this indicator should use DWR's Water Audit program. The program provides an accounting procedure using agency data to determine water loss that may be due to distribution system leaks. The program requires the agency to determine an audit period and gather data for that period. DWR provides a guidebook that defines the types of data necessary and contains worksheets to guide an audit. These resources help ensure standardized data collection. Leak Detection programs are typically established following the determination of the percentage of water loss and a benefit-cost analysis to verify economic feasibility.

Distribution systems with a high percentage of water loss may require a leak detection program or upgrades to existing infrastructure. This indicator may also show what areas of California most require Leak Detection programs.

In 2018, the Legislature enacted two policy bills – SB 606 and AB 1668 – to establish both the foundation and needed authorities for long-term improvements in water conservation and drought planning to adapt to climate change and the resulting longer and more intense droughts in California. These bills amended the California Water Code, requiring state agencies to develop statewide water use targets, standards, and guidelines, and water agencies to then report on progress towards meeting those requirements. During the implementation process, DWR and other State agencies will further develop data, information, guidelines, and other technical assistance to help realize the bills' intended outcomes. Both bills include requirements for public access to data and their use, as well as related studies, reports, and investigations. These data, studies, reports, and investigations may be of use to continued development of this indicator.

References

California Department of Water Resources. "Submitted 2015 Urban Water Management Plans (UWMP) Data Exports." Water Use Efficiency Data Public Portal. Viewed online at: <https://wuedata.water.ca.gov/default.asp>. Last accessed: January 10, 2018.

California Department of Water Resources. 2016. Water Audit Manual. Prepared by: Water Systems Optimization. Viewed online at: <http://www.water.ca.gov/urbanwatermanagement/docs/2015/DWR%20Water%20Audit%20Manual%20FINAL.pdf>

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply

HE 4: Groundwater Basins with Stable or Recovering Groundwater Levels

This indicator assesses the overall health of groundwater basins throughout the state through assessment of groundwater levels. The California Statewide Groundwater Elevation Monitoring (CASGEM) Program tracks seasonal and long-term groundwater elevation trends in groundwater basins statewide. This information is reported through the DWR Groundwater Information Center.

The target outcome or trend for this indicator is to show stable or recovering groundwater levels in groundwater basins throughout the state, indicating continued reliability of groundwater supplies.

Scale:	Statewide
Data Sources:	DWR Groundwater Information Center
Data Availability:	Type I
Metric:	Groundwater levels
Screening Status:	Basic

Importance and Screening Considerations

Groundwater levels directly impact the availability of water to those that use it. As groundwater levels drop, pumping costs rise. Driven by recent and extended droughts, groundwater levels have declined at rapid rates. Rapid declines can lead to subsidence, resulting in costly damage to water supply, transportation, and flood infrastructure. Despite efforts initiated through SGMA to reverse historical trends, significant investment and time will be necessary to achieve more sustainable management of groundwater in California.

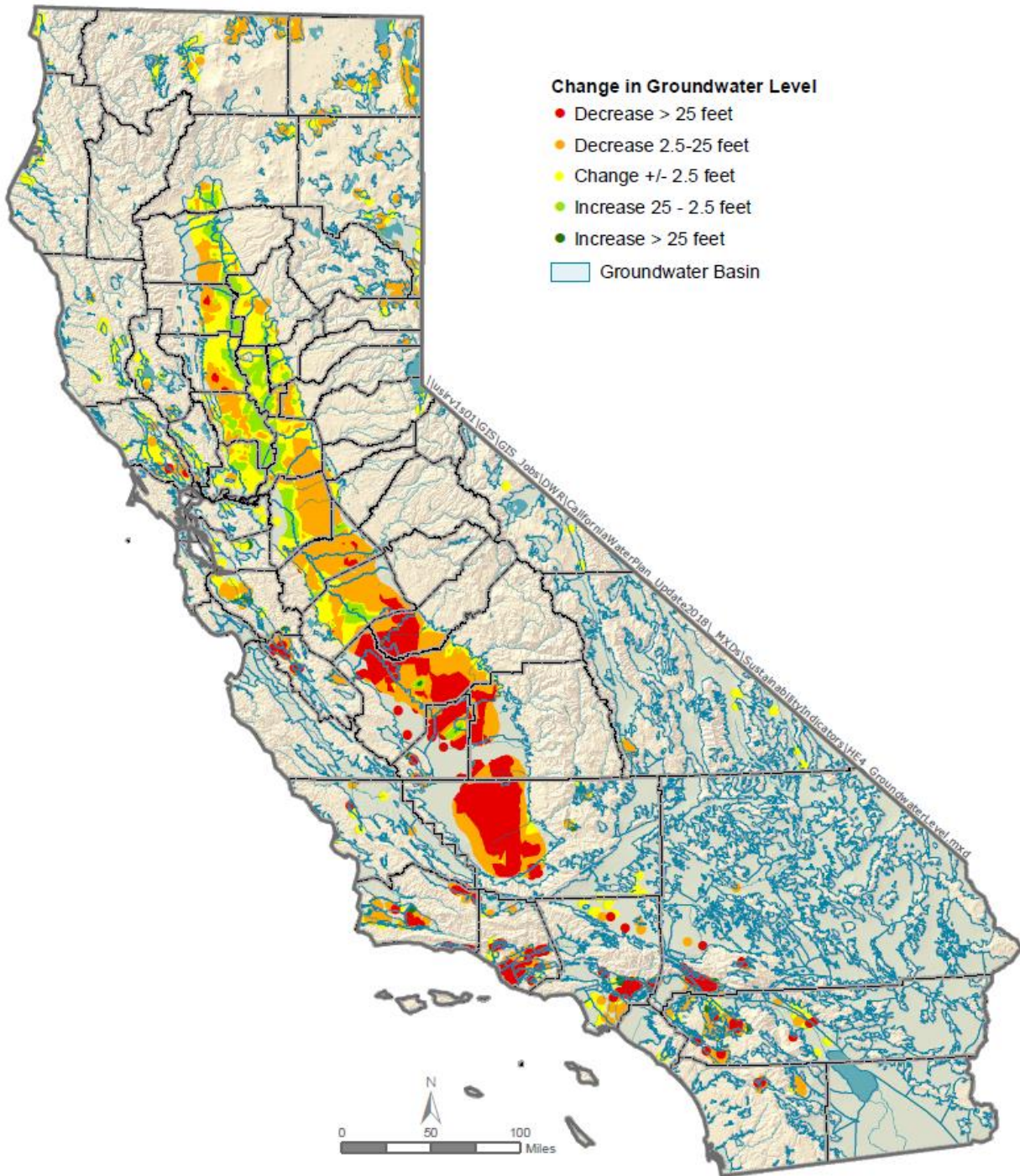
This indicator is considered Basic level. Data on groundwater levels are readily available through CASGEM in most groundwater basins and additional data may soon be available through SGMA. This indicator represents the intended outcome and is a good assessment of trends associated with groundwater basin health over time.

Representative of Outcome:	High
Data Viability:	Medium-High
Cost:	Medium-High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Initial data for this indicator were downloaded from DWR's Groundwater Information Center. This information is collected from CASGEM and other DWR programs for groundwater basins throughout the state. The changes in groundwater level throughout the state can be shown both through levels at individual points and through contours that provide a smoothed approximation of groundwater levels.

Figure 4-23 shows the change in groundwater levels throughout the state from spring 2012 to spring 2017. A period of five years was considered to include the cumulative impacts of both dry and wet years. Groundwater levels have decreased significantly in most basins in the southern half of the state, while areas in the northern half of the state have seen some recovery in groundwater levels since 2012. As can be seen in the map, groundwater elevation data are lacking for many basins in the southeast portion of the state. However, the majority of these basins are not considered high or medium priority basins by DWR. The criteria to determine priority designation considers population, number of wells, irrigated acreage, and documented impacts on groundwater within the basin.



Source: "Groundwater Information Center." California Department of Water Resources. December 21, 2017.

Figure 4-23. Change in Groundwater Levels from Spring 2012 to Spring 2017

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework will continue to develop. Declining groundwater levels can cause additional pumping expenses, loss of reliable water supplies, and potential subsidence. Additional data should be gathered to augment existing data for basins outside of the Central Valley to allow more detailed contours to be developed for these areas. SGMA may provide the necessary tools to gather some of these data in high and medium priority basins where there is currently no available information.

References

California Department of Water Resources. "Groundwater Information System." CASGEM Public Portal. Viewed online at: <http://water.ca.gov/groundwater/gwinfo/>. Last accessed: December 21, 2017.

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply

HE 5: Groundwater Extraction Rates and Subsidence Rates

This indicator assesses the groundwater extraction rates and subsidence rates in each groundwater basin statewide. This indicator is related to *HE 4: Groundwater Basins with Stable or Recovering Groundwater Levels*. As groundwater levels decrease, aquifers can compact, causing land subsidence. Groundwater levels decrease when the rate of groundwater extraction is higher than the rate of groundwater recharge.

DWR has a long-standing history of collecting and analyzing groundwater data and investigating and reporting groundwater conditions. DWR is responsible for implementing SGMA and CASGEM, and for characterizing California's groundwater basins through Bulletin 118 updates. Future data for this indicator may be developed through SGMA implementation. Potential additional data sources include the State Water Board and National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL) groundwater data.

The target outcome for this indicator are sustainable groundwater extraction rates that do not lead to further land subsidence or other undesirable results as defined through SGMA.

Scale:	Regional
Data Sources:	SGMA, State Water Board, NASA JPL
Data Availability:	Type III
Metric:	Groundwater extraction rates and land subsidence rates
Screening Status:	Basic (Future)

Importance and Screening Considerations

Groundwater resources play a vital role in maintaining California's economic and environmental sustainability. During dry years, groundwater contributes up to 46 percent of the water supply statewide and serves as a critical buffer against the impacts of drought and climate change. Some communities in the state rely solely on groundwater to meet water supply needs. Groundwater extraction in excess of natural and managed recharge has caused historically-low groundwater elevations and led to alarming subsidence rates in many regions of California.

During the screening process, this indicator was considered a Watershed level indicator. The screening status has been changed to Basic (Future), based on current data availability. Data may only be available following further development of Groundwater Sustainability Plans and other SGMA implementation activities. However, this indicator is easy to measure, simple to understand, and clear on actions that need to be taken. Once data are developed, this indicator may prove to be more relevant in certain watersheds or regions and require a more in-depth analysis for these specific regions.

Representative of Outcome:	Medium-High
Data Viability:	Low-Medium
Cost:	Medium
Potential Longevity:	Medium-High

Supportive of Decision Making: High

Initial Data and Results

No initial data are presented. Data must be further developed, through SGMA, for a methodology to be developed.

Recommendations

This indicator is Basic (Future) level, as large data gaps prevent the development of guidelines and methodology. Declining groundwater levels due to over pumping affect water supply reliability and may also threaten existing infrastructure due to subsidence. Little monitoring of groundwater extraction rates occurs under current regulations.

This indicator may need to be redefined or recombined with other indicators to provide useful information to decision makers. Subsidence rates may be more directly tied to groundwater levels. Areas of subsidence could be shown as part of *HE 4, Groundwater Basins with Stable or Recovering Groundwater Levels*. This indicator would cover only groundwater extraction rates and/or include information on recharge rates.

References

National Aeronautics and Space Administration. California Institute of Technology, Jet Propulsion Laboratory. Viewed online at: <https://www.jpl.nasa.gov/>. Last accessed: December 21, 2017.

California Department of Water Resources. SGMA Public Portal. Viewed online at: <http://www.water.ca.gov/groundwater/sgm/>. Last accessed: December 12, 2017.

California Department of Water Resources. "Groundwater Information Center." CASGEM Public Portal. Viewed online at: <http://water.ca.gov/groundwater/gwinfo/>. Last accessed: December 21, 2017.

Legislative Analyst's Office. 2017. Overview of the Sustainable Groundwater Management Act. Viewed online at: <http://www.lao.ca.gov/handouts/resources/2017/Overview-Sustainable-Groundwater-Management-Act-031617.pdf>

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply

HE 6: Change in Groundwater Storage

This indicator assesses the change in available groundwater storage. Through analysis of subsidence, recharge rates, and extraction rates, the change in groundwater storage can be estimated throughout the state. However, data are lacking pending further collection under SGMA requirements. Additional potential data sources include CASGEM, the State Water Board, and NASA's JPL groundwater data.

The target outcome for this indicator would show no change or an increase in groundwater storage available.

Scale:	Regional
Data Sources:	DWR SGMA; NASA JPL; CASGEM; State Water Board
Data Availability:	Type III
Metric:	Groundwater storage (acre-feet)
Screening Status:	Basic

Importance and Screening Considerations

Over pumping groundwater not only leads to an immediate depleted supply of groundwater, but can also effect aquifer's abilities to store water in the future. Decades of over pumping groundwater have irreversibly altered layers of clay beneath California's Central Valley, which has permanently reduced aquifer storage capacity.

This indicator was considered Basic level during the screening process. The screening status has been changed to Basic (Future), based on a lack of available data. Data may be developed through SGMA in individual basins' Groundwater Sustainability Plans. Decrease in groundwater storage impacts groundwater supply reliability, relating directly to the intended outcome.

Representative of Outcome:	Medium-High
Data Viability:	Medium-High
Cost:	Medium-High
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

No initial data are presented as changes in groundwater storage are not currently tracked at a state level. A potential description of methodology is presented below.

Recommendations

This indicator is considered a Basic (Future) level indicator. Additional data are required to develop a methodology for this indicator. Potentially, this indicator would attempt to highlight basins impacted by decreased groundwater storage. Combining this indicator with, or considering this indicator in

conjunction with, *HE 4, Groundwater Basins with Stable or Recovering Groundwater Levels*, or *HE 5, Groundwater Extraction and Subsidence Rates* may provide a more detailed picture of the health of groundwater basins throughout California.

This indicator should be further developed following the development of Groundwater Sustainability Plans under SGMA requirements, which may provide the necessary data.

References

National Aeronautics and Space Administration. California Institute of Technology, Jet Propulsion Laboratory. Viewed online at: <https://www.jpl.nasa.gov/>. Last accessed: December 21, 2017.

California Department of Water Resources. SGMA Public Portal. Viewed online at: <http://www.water.ca.gov/groundwater/sgm/>. Last accessed: December 12, 2017.

California Department of Water Resources. “Groundwater Information Center.” CASGEM Public Portal. Viewed online at: <http://water.ca.gov/groundwater/gwinfo/>. Last accessed: December 21, 2017.

Legislative Analyst’s Office. 2017. Overview of the Sustainable Groundwater Management Act. Viewed online at: <http://www.lao.ca.gov/handouts/resources/2017/Overview-Sustainable-Groundwater-Management-Act-031617.pdf>

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply

HE 7: Percentage of Groundwater Basin Areas in Compliance with SGMA

This indicator assesses the groundwater basins in compliance with SGMA requirements, including actions required by Groundwater Sustainability Agencies (GSA) and the requirements for Groundwater Management Plans (GMP)/Groundwater Sustainability Plans (GSP).

SGMA requires groundwater-dependent regions to halt overdraft and bring basins into balanced levels of pumping and recharge. SGMA helps define sustainable groundwater management. Basins were sorted into four priority categories – high, medium, low, and very low. Compliance with SGMA is mandatory for high and medium basins, although low and very low priority basins may elect to participate. Through a multi-phase process, local agencies must form GSAs. These GSAs must then adopt and implement GSPs that fulfill basic requirements. DWR has launched the Sustainable Groundwater Management Program to implement the law and provide ongoing support to local agencies around the state.

The target outcome for this indicator is for all groundwater basins, in their entirety, to be in compliance with their respective requirements under SGMA. Basins without requirements are not included.

Scale:	Statewide
Data Sources:	DWR SGMA Portal
Data Availability:	Type III
Metric:	Areas in compliance with SGMA
Screening Status:	Basic

Importance and Screening Considerations

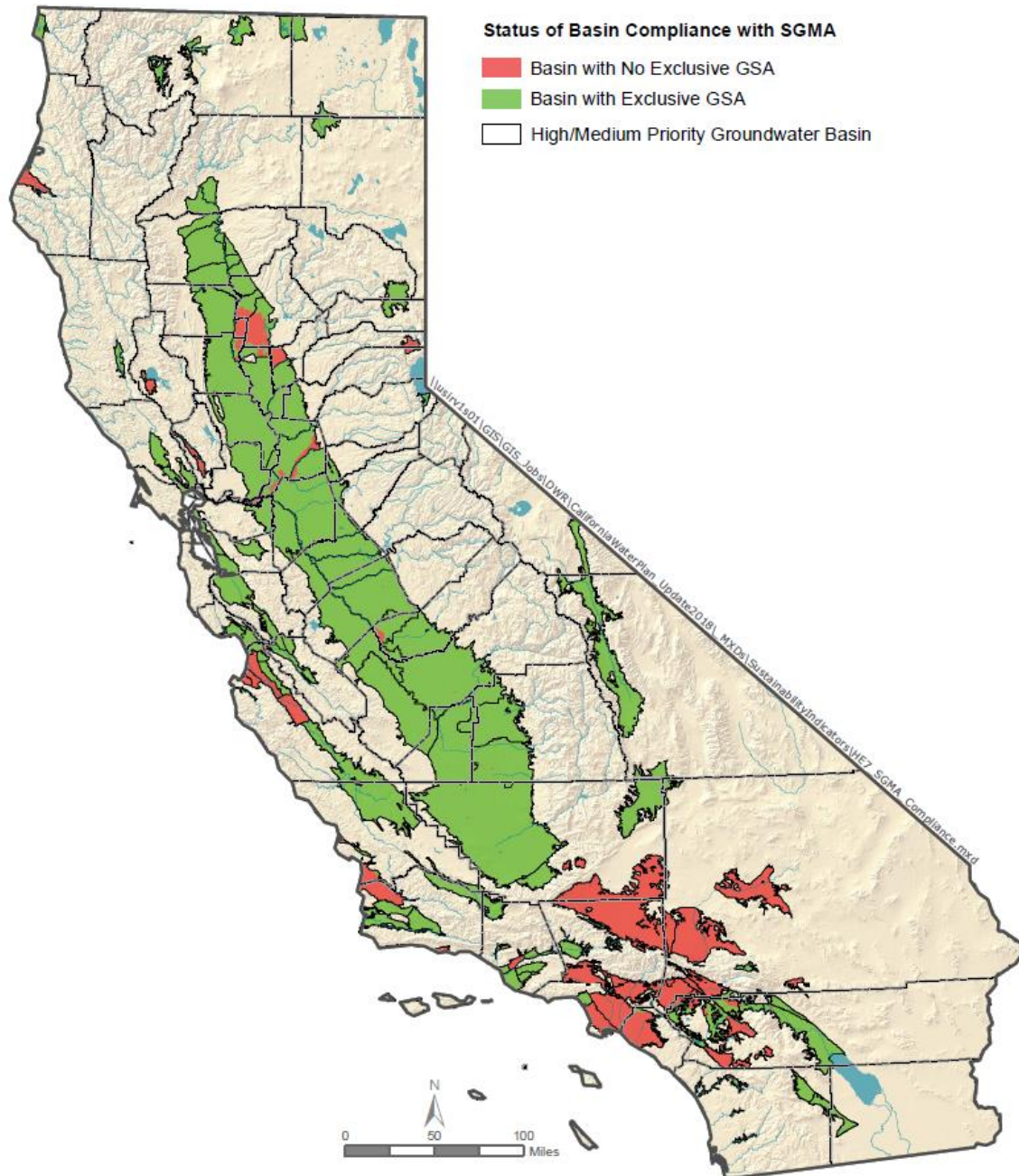
Groundwater is the primary, and in some cases sole, source of water for many communities in California. SGMA is evidence that California recognizes groundwater is a vital resource for the state that must be managed sustainably. SGMA implementation will help direct efforts to monitor and regulate groundwater use in the state. Some regions have developed GMPs under other sections of California legislation and in advance of SGMA requirements. However, GSAs have formed throughout the state in high and medium priority basins and are developing GSPs, as currently required by SGMA.

This indicator is considered a Basic level indicator. This indicator is easy to measure, simple to understand, and clear on actions to be taken statewide.

Representative of Outcome:	Medium-High
Data Viability:	High
Cost:	Low
Potential Longevity:	High
Supportive of Decision Making:	Medium

Initial Data and Results

Current requirements under SGMA state that by June 30, 2017, local agencies must establish GSAs in all high and medium priority basins. These GSAs must be exclusive; exclusive GSAs do not have overlapping boundaries. Although GMPs exist for many of these basins, no GSPs are required under SGMA in any basin until January 31, 2020. GSAs have been formed across the state in most high and medium groundwater basins as well as in basins with lower priority. Small areas remain unmanaged. The high and medium priority basins in compliance are shown in Figure 4-24.



Source: "GSA Map" SGMA Public Portal. California Department of Water Resources. December 12, 2017.

Figure 4-24. Current Progress of Exclusive Groundwater Sustainability Agency Formation in High and Medium Priority Basins

Table 4-12 lists the basins with a substantial portion of the high or medium priority groundwater basin being unmanaged, as shown in the figure above in red. Substantial is considered here as over 10 percent of a groundwater basin's total area.

Table 4-12. Unmanaged Areas of Groundwater Basins

Groundwater Basin	Unmanaged Area of Basin (%)	Location of Basin
8-2.04	100%	Upper Santa Ana Valley
4-11.04	100%	Coastal Plain Of Los Angeles
5-21.60	100%	Sacramento Valley
8-2.06	100%	Upper Santa Ana Valley
1-10	100%	Eel River Valley
2-2.01	100%	Napa-Sonoma Valley
3-16	100%	Goleta
3-4.04	100%	Salinas Valley
3-4.08	100%	Salinas Valley
4-23	100%	Raymond
5-15	100%	Big Valley
5-27	100%	Cummings Valley
5-28	100%	Tehachapi Valley West
6-40	100%	Lower Mojave River Valley
6-42	100%	Upper Mojave River Valley
6-43	100%	El Mirage Valley
6-67	100%	Martis Valley
7-12	100%	Warren Valley
8-2.02	100%	Upper Santa Ana Valley
9-4	100%	Santa Margarita Valley
4-11.03	100%	Coastal Plain Of Los Angeles
9-5	100%	Temecula Valley
3-4.01	100%	Salinas Valley
4-12	99%	San Fernando Valley
6-44	97%	Antelope Valley
4-13	97%	San Gabriel Valley
8-1	96%	Coastal Plain Of Orange County
8-2.01	95%	Upper Santa Ana Valley
3-4.10	94%	Salinas Valley
3-12	88%	Santa Maria
4-4.04	87%	Santa Clara River Valley
5-14	69%	Scotts Valley
8-2.03	69%	Upper Santa Ana Valley
3-8	66%	Los Osos Valley
5-21.58	55%	Sacramento Valley
5-21.59	52%	Sacramento Valley
8-5	49%	San Jacinto
8-2.08	25%	Upper Santa Ana Valley
5-21.65	17%	Sacramento Valley

Regions with no exclusive GSA may be working towards defining boundaries to remove overlaps of multiple GSAs. However, basins not managed by one or more GSAs that cover the entire basin, as of June 20, 2017, face additional requirements for monitoring extraction rates. The first GSPs will be required for basins in critical overdraft starting January 31, 2020.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework will continue to develop. Monitoring the progress of agencies through the SGMA framework allows decision makers to see how local groundwater management is occurring.

Future methodology would involve gathering data from DWR's SGMA Portal for information on each GSA and its plan's compliance, and then correlating this information with the basin area covered by the GSA. SGMA establishes the requirements to be used to check whether plans are in compliance.

References

California Department of Water Resources. "GSA Map." SGMA Public Portal. Viewed online at: http://water.ca.gov/groundwater/sgm/gsa_map.cfm. Last accessed: December 12, 2017.

Legislative Analyst's Office. 2017. Overview of the Sustainable Groundwater Management Act. Viewed online at: <http://www.lao.ca.gov/handouts/resources/2017/Overview-Sustainable-Groundwater-Management-Act-031617.pdf>

State Water Resources Control Board. "Unmanaged Area Identification." State Water Board SGMA. Viewed online at: <https://waterboards.maps.arcgis.com/apps/MapJournal/index.html?appid=3ca8bf4bbd6e40aaa561b7ed06821f72>. Last accessed: December 12, 2017.

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply

HE 8: Contaminated Groundwater Wells

This indicator assesses the number of groundwater wells throughout the state that are contaminated. Groundwater is the primary, and in some cases sole, source of water for many communities in California.

A groundwater well's depth from the surface, quality for drinking water, and chance of being polluted vary from place to place. Groundwater may contain some natural contaminants or dissolved elements such as arsenic or radon. Human activities, such as improper use of fertilizers or chemical spills, can also contaminate groundwater. Both natural contamination and human related activities can lead to unacceptable drinking water quality and an increase in the cost of treatment required.

This indicator is similar to an archived indicator, *PHS: Number of People and Percent of Population Relying on Contaminated Groundwater for Domestic Water Supply*, which was archived due to the overlap of the two indicators.

The target outcome for this indicator is that all groundwater wells meet drinking water quality standards.

Scale:	Regional
Data Sources:	State Water Board; GAMA; DWR CASGEM
Data Availability:	Type II
Metric:	Percent of wells out of compliance
Screening Status:	Basic

Importance and Screening Considerations

On average, about 30 percent of Californian's drinking water comes from groundwater. In years of drought when surface water is scarce, there is a greater dependence on groundwater. Nearly 21 million people live in communities that rely on contaminated groundwater as part of their supply. Of those communities, 75 percent do not have a surface water supply and must rely solely on contaminated groundwater. For almost 5 percent of the state's population, a private groundwater well is the sole source of drinking water. Groundwater can be contaminated by natural causes or human activities, such as agricultural or industrial processes. Contamination of groundwater threatens not both public health and economic health. An increase in required groundwater treatment, rehabilitation of a contaminated well, or development of a new well all come at a cost and can increase the cost of water to end users.

This indicator is considered a Basic level indicator. Available data cover only a portion of potentially contaminated groundwater wells, as information on private wells is incomplete. Private domestic well owners are encouraged to test well water quality regularly, but this is not required or recorded by the State. As such, there are significant data gaps in information on the water quality of private wells. Gathering additional data would come at a relatively high cost, as sampling and analyses to determine if any one well meets all drinking water quality standards may take significant effort. Another obstacle for this indicator is the potential variation over time of groundwater quality, potentially necessitating frequent sampling. However, where data are available, it is easy to determine if a well exceeds contaminant limits.

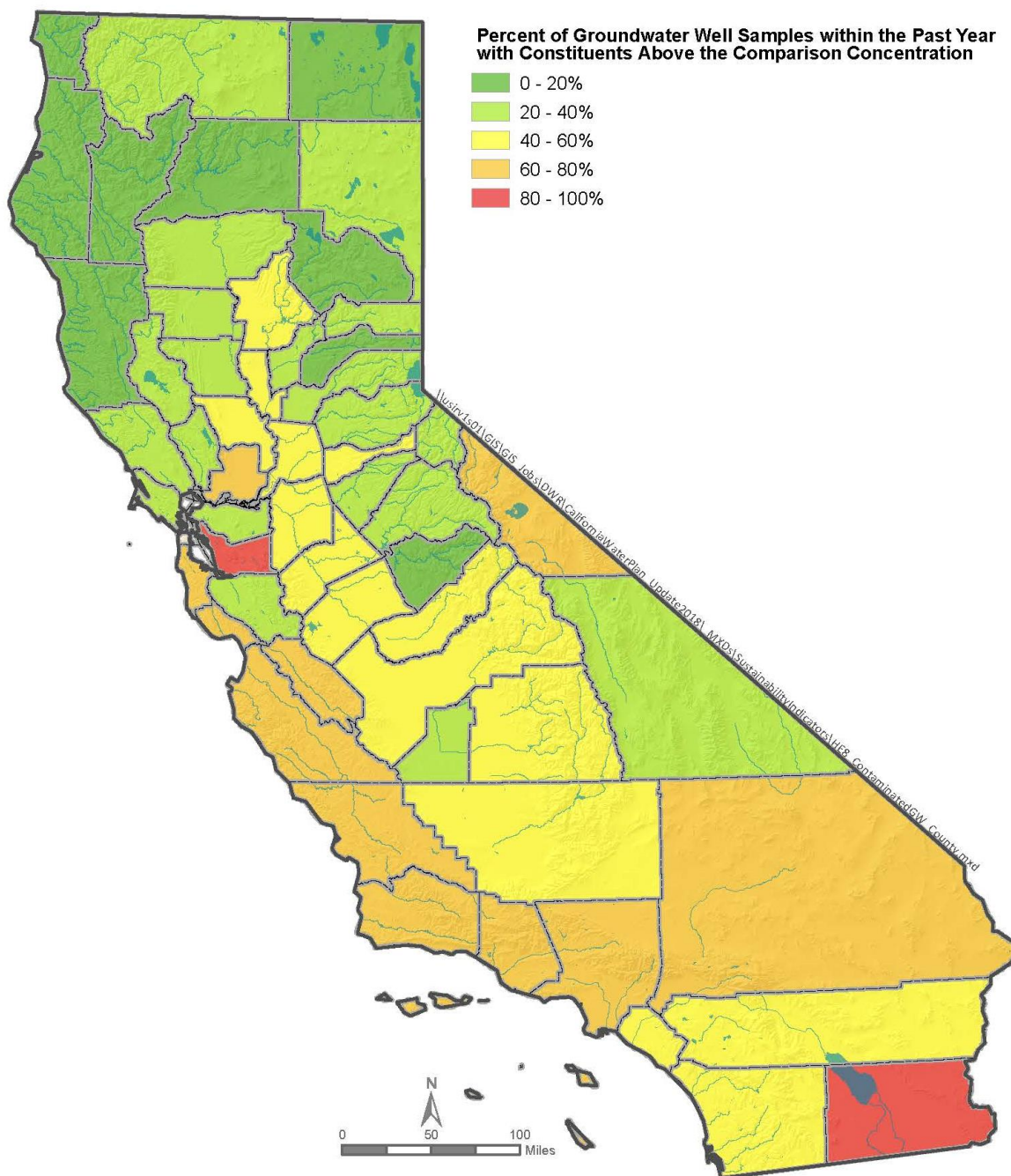
This indicator is measured as a percentage instead of a total count so that an increase in sampling does not necessarily correlate with diminished results.

Representative of Outcome:	Medium-High
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

Initial Data and Results

The State Water Board is required to monitor public water systems that rely on contaminated groundwater sources and report this information to the Legislature. The State Water Board created the GAMA Program to monitor and assess groundwater quality across the state. The GeoTracker GAMA tool combines groundwater information from multiple datasets and visually displays the data on a map. For this analysis, all samples taken in the previous year across all datasets available in this tool were analyzed. Samples that found constituents above the GeoTracker GAMA's comparison concentrations were compared to the total number of samples taken. The percentages were then summarized by county. Figure 4-25 shows the results of this analysis. San Francisco County did not have any recorded samples from the previous year in the GeoTracker GAMA database at the time of analysis. It is important to reiterate that there are data missing in every county due to the small number of private wells that have been sampled.

The data collected for this indicator only represent communities that are more reliant on groundwater than surface water. In addition, the data only cover a portion of the population's exposure to contaminated groundwater because information from private wells is expensive to collect. Private well data are not regulated at the State level, but private domestic well owners are encouraged to test well water quality regularly.



Source: GeoTracker GAMA. State Water Resources Control Board. February 8, 2018.

Figure 4-25. Wells Where Contaminated Groundwater Has Been Detected (Feb 2017–Jan 2018)

Recommendations

This indicator is considered a Basic level indicator. More data are needed to strengthen the accuracy of this indicator. California does not require sampling of private wells after installation, so individual owners may or may not conduct water quality testing. GAMA's Domestic Well Project helps bridge the gap in information between public and private wells, but there is considerable progress still to be made.

GAMA's goals include improving comprehensive groundwater water quality monitoring, and making this data publicly available. As these goals are recognized, comprehensive comparison of well water quality to drinking water standards could be made and the number of groundwater wells not meeting those standards could be better quantified. By expanding this program to a comprehensive statewide reach, a holistic picture of domestic groundwater well quality could be assessed.

Another potential source to increase the viability of this indicator is SGMA. As SGMA implementation continues to play an increased role in groundwater management, more data on groundwater quality should be available. It is important to note that not all groundwater wells are used for drinking water, so not all wells need to or should be required to meet the stringent drinking water requirements and doing so could be economically detrimental. Water quality should be matched to the beneficial use of the water.

This indicator differs from the archived indicator *PHS: Number of People and Percent of Population Relying on Contaminated Groundwater for Domestic Water Supply* in that it assesses many water contaminant limits, not only those for drinking water. Different groundwater uses require different levels of treatment and have varying effects on the local economy.

While the GAMA Domestic Well Project collects data on contaminated groundwater wells, these data have not been developed to the same extent for all counties. Additional funding is needed for this program to continue making progress.

As SGMA continues to play a role in groundwater management, more data on groundwater quality will be available into the future. Data from SGMA may potentially change the preferred methodology for this indicator.

References

State Water Resources Control Board. 2013. Communities that Rely on a Contaminated Groundwater Source for Drinking Water. Viewed online at:

<https://www.waterboards.ca.gov/gama/ab2222/docs/ab2222.pdf>

State Water Resources Control Board. 2015. Safe Drinking Water Plan for California. Viewed online at:

https://www.waterboards.ca.gov/publications_forms/publications/legislative/docs/2015/sdwp.pdf

State Water Resources Control Board. Groundwater Ambient Monitoring and Assessment Program.

Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/gama/. Last accessed: February 8, 2018.

U.S. Department of the Interior, U.S. Geologic Survey. "Groundwater Ambient Monitoring and Assessment Program." California Water Science Center. Viewed online at:

<https://ca.water.usgs.gov/projects/gama/>. Last accessed: February 8, 2018.

State Water Resources Control Board. GeoTracker GAMA. Viewed online at:

<http://geotracker.waterboards.ca.gov/gama/>. Last accessed: February 8, 2018.

State Water Resources Control Board. 2015. A Guide for Private Domestic Well Owners. Viewed online at: https://www.waterboards.ca.gov/gama/docs/wellowner_guide.pdf

Healthy Economy

Intended Outcome: Consideration of economic risks and rewards on floodplains, rivers, and coastal areas.

HE 9: Socioeconomic Vulnerability to Sea Level Rise Impacts

This indicator assesses the socioeconomic vulnerability of coastal area acreage at risk of sea level rise. Coastal California is experiencing the early impacts of rising sea levels, including more extensive coastal flooding during storms, periodic tidal flooding, and increased coastal erosion. Some coastal areas may be more prepared to respond to sea level rise impacts than others due to differences in socioeconomic variables.

The target outcome for this indicator is that all coastal areas show low socioeconomic vulnerability to sea level rise impacts. Low socioeconomic vulnerability indicates an area has relatively more capacity to prepare for, respond to, and recover from hazards than areas that show high socioeconomic vulnerability.

Scale:	Regional
Data Sources:	National Oceanic and Atmospheric Administration (NOAA); California Ocean Protection Council
Data Availability:	Type I
Metric:	Social Vulnerability Index and acreage of coastal land impacted by sea level rise
Screening Status:	Basic

Importance and Screening Considerations

Global sea-level rise attributed to climate change will have far-reaching consequences for California, which has about 1,100-miles of open coastline, many additional miles of estuarine shorelines, and high concentrations of people and development along the coast. If sea levels continue to rise, hundreds of miles of already developed land and other economic assets are at risk from future flooding, inundation, and coastal retreat.

This indicator is considered a Basic level indicator. It reflects the goal associated with the intended outcome and is representative of economic risks in coastal areas. This indicator may inform future economic decisions associated with land development in coastal regions.

Representative of Outcome:	High
Data Viability:	Medium-High
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	High

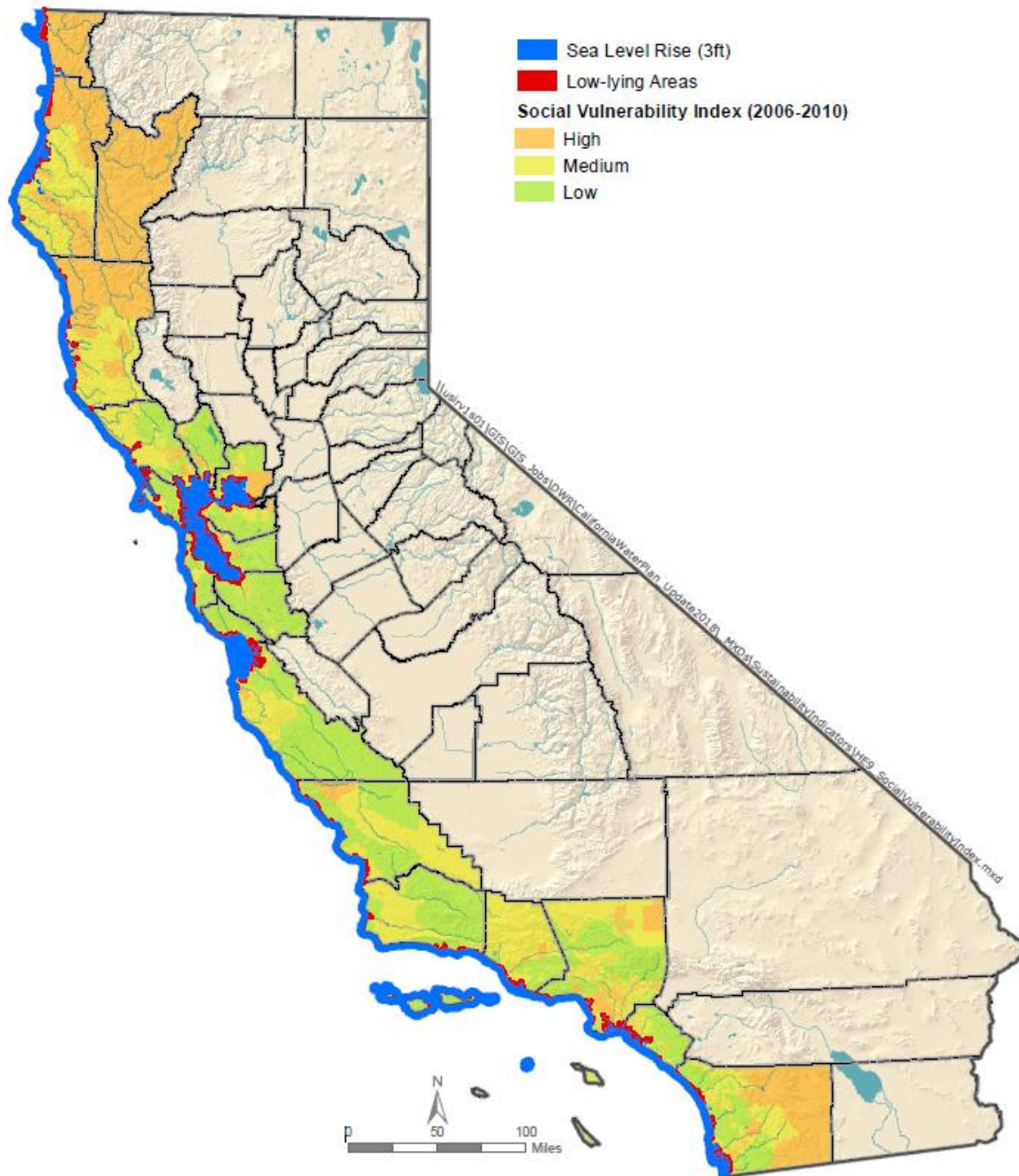
Initial Data and Results

Data mapped from NOAA's Sea Level Rise Viewer were used to develop Figure 4-26. Sea Level Rise Viewer data are updated as new elevation data are collected by a wide range of agencies. The mapping tool helps visualize community-level impacts from coastal flooding or sea level rise (up to 6 feet above

average high tides). For the purposes of this indicator, the 3 feet above average high tides sea level rise scenario was mapped, as well as the hydrologically “unconnected” low lying areas that may also flood from a 3 feet sea level rise scenario.

The maps in the data viewer are derived from source elevation data that meet or exceed FEMA mapping specifications for the National Flood Insurance Program, which consider 0.6 feet root mean square error for low relief terrain and 1.2 feet for high relief terrain. The data also include future flooding impacts on socioeconomic vulnerability, which will assess the potential impact that sea level rise can have on vulnerable people and businesses along the coast of California.

The Hazards and Vulnerability Research Institute at the University of South Carolina’s Social Vulnerability Index shows areas of human vulnerability to hazards and is based on population attributes from Census 2010 and the built environment. The index synthesizes 29 socioeconomic variables, helping illustrate the geographic variation in social vulnerability. Examples of socioeconomic variables used to process the Social Vulnerability Index score include family structure, language barriers, vehicle availability, medical disabilities, healthcare access, wealth, race and social status, elderly residents, and service industry employment. The socioeconomic index score suggests a county’s ability to prepare for, respond to, and recover from hazards. Index scores are relative – high scores in the top 20 percent of the United States denote the most vulnerable areas and low scores in the bottom 20 percent of the United States denote the least vulnerable areas.



Source: Sea Level Rise Viewer. National Oceanic and Atmospheric Administration. February 9, 2018.

Figure 4-26. Coastal Areas at Risk of Sea Level Rise Evaluated with the Social Vulnerability Index of the Coastal Areas

As demonstrated in Figure 4-26, some areas along the coast have a relatively lower capacity for preparedness and response (indicated by a high Social Vulnerability Index score) to most effectively reduce pre-existing vulnerability to environmental hazards, such as flooding from sea level rise. In general, the areas that are most impacted by sea-level rise issues and coastal flooding exhibit low to medium vulnerability to the impacts of environmental hazards, as shown in Table 4-13. This indicates areas most impacted by flooding from sea-level rise are relatively more prepared than other areas

exhibiting low capacity for preparedness and response to environmental hazards. Approximately 16.5 percent of the acreage at risk of sea level rise impacts are correlated with areas showing high vulnerability and lower capacity for preparedness and response to impacts.

Table 4-13. Acreage of Coastal Areas Vulnerable to Sea Level Rise Impacts

Social Vulnerability Index	Acreage of Land at Risk of Sea Level Rise (acres)	Percentage of Land at Risk of Sea Level Rise
High (most vulnerable)	52,726	16.5%
Medium	180,812	56.6%
Low (least vulnerable)	85,638	26.8%

Source: Sea Level Rise Viewer. National Oceanic and Atmospheric Administration. February 9, 2018.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework will continue to develop. In order to more adequately consider the economic risks associated with sea level rise, information on both land use types and assets at risk are needed to more fully understand a county's potential risk and its ability to prepare or respond to sea level rise impacts.

The California Coastal Commission currently summarizes county level snapshots in the 2016 Statewide Sea Level Rise Vulnerability Synthesis report. *HE 10 Areas Covered by Local Coastal Program Vulnerability Assessments Updated for Sea Level Rise* evaluates some information from the report, including the status of the sea level rise vulnerability assessments. Additional information referenced in the report that could help support this indicator includes coastal zone resources categorized as ports and harbors, whether coastal zone resources are publicly owned/accessible, public access coastal areas, and coastal zone wetlands as well as ocean economy represented as an ocean sector's gross domestic product (GDP). However, the data provided in each county snapshot are not georeferenced. In the future, georeferencing the information already collected in the county snapshots, specifically the coastal zone resources, would benefit the evaluation of this indicator. Representing the county percent GDP of State Ocean Sector GDP on the map already developed for this indicator or on a separate map should also be considered for inclusion.

References

- California Ocean Science Trust. 2017. Rising Seas in California: An Update on Sea-Level Rise Science. Prepared by: California Ocean Protection Council Science Advisory Team Working Group. Viewed online at: <http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf>
- National Oceanic and Atmospheric Administration. Sea Level Rise Viewer. Viewed online at: <http://bit.ly/2Etz45E>. Last accessed: February 9, 2018.
- Hazards & Vulnerability Research Institute. "SoVI® - Social Vulnerability Index for the United States – 2010-2014." University of South Carolina. Viewed online at: <http://artsandsciences.sc.edu/geog/hvri/sovi%C2%AE-0> . Last accessed: February 8, 2018.

Healthy Economy

Intended Outcome: Consideration of economic risks and rewards on floodplains, rivers, and coastal areas.

HE 10: Areas Covered by Local Coastal Program Vulnerability Assessments Updated for Sea Level Rise

This indicator assesses the acreage of land vulnerable to sea level rise covered and not covered by Local Coastal Program (LCP) Vulnerability Assessments updated for sea level rise. LCPs have been developed by local governments with the help of the California Coastal Commission, so that local governments can permit development at the local level consistent with the policies of the Coastal Act.

The target outcome for this indicator is that all areas at risk of sea level rise will have LCP Vulnerability Assessments updated for sea level rise. This will help ensure effective planning and permitting of development in California's coastal zone.

Scale:	Regional
Data Sources:	California Coastal Commission
Data Availability:	Type II
Metric:	Status of LCP Vulnerability Assessments
Screening Status:	Basic

Importance and Screening Considerations

Many aspects of the coastal economy, as well as California's broader economy, are at risk from sea level rise, including coastal-related tourism, beach and ocean recreational activities, transfer of goods and services through ports and transportation networks, coastal agriculture, and commercial fishing and aquaculture facilities. As many economic opportunities are at stake, California's coastal communities must make adaptation to sea level rise a priority through Vulnerability Assessments in order to minimize damage and losses.

Rising sea levels of up to 1.4 meters by 2100 will have significant impacts on California's coastline. While bays and estuaries are expected to experience the most significant impacts in the coming century, changes will also be realized far inland from the shoreline zone. These changes will lead to consequences for sovereign public trust lands, resources, and assets, and may lead to significant economic impacts.

This indicator is considered a Basic level indicator. Although this indicator is more relevant in coastal regions, sea level rise issues could have major implications on California's economy statewide. Evaluation of this indicator may require compiling data from multiple sources and entities, but would be very supportive of decision making for policies regarding sea level rise issues.

Representative of Outcome:	Medium
Data Viability:	High
Cost:	Low-Medium
Potential Longevity:	High
Supportive of Decision Making:	Medium-High

Initial Data and Results

The California Coastal Commission released the Statewide Sea Level Rise Vulnerability Synthesis report in December 2016. The report presents key statewide findings on vulnerability to inform sea level rise planning and preparedness, as well as county-level snapshots which describe sea level rise vulnerability at a county scale and local planning efforts underway. The California Coastal Commission works with local governments to develop LCPs. The LCPs provide the legally-controlling local land use policies and zoning to address statewide coastal resource management issues such as sea level rise.

Some of the key findings from the 2016 report include the following:

- The ocean economy makes up a significant portion of California's total economy.
- The largest coastal zone populations vulnerable to flooding from a 100-year storm plus 55 inches sea level rise are Los Angeles, Orange, and San Diego counties.
- Many of the vulnerability assessments did not account for the full range of social impacts linked to sea level rise. Vulnerability to hazards from sea level rise will have a disproportionate impact on communities with the least capacity to adapt.
- Despite many miles of existing armoring, erosion will continue to threaten existing developed areas in vulnerable communities, and this threat will increase with rising sea level.
- Public access and recreational assets are threatened by sea level rise in every county.
- Many communities have not yet addressed the vulnerability of their sandy beaches to rising sea levels.
- Sea level rise poses significant threats to agricultural resources where it can cause an increase in flooding an inundation of low-lying agricultural land, saltwater intrusion into agricultural water supplies, and/or a decrease in the amount of freshwater available for agricultural uses.
- LCP policies to address new development, known vulnerabilities, general hazard response, and future specific adaptation methods provide the mechanism to develop resilience to sea level rise. Communities should begin planning so that actions now do not preclude future adaptation options.

Figure 4-27 provides a visual representation of the status of each LCP Vulnerability Assessment in the coastal zone. There are three broad descriptions the California Coastal Commission uses to track if an LCP has been updated for sea level rise: (1) "in progress" means that the jurisdiction has grant or other ongoing work to address the impacts of climate change; (2) "in part" means the LCP has mentioned sea level rise to some extent; and (3) "no" means the LCP has no mention of sea level rise. Those broad descriptions are translated into the Figure 4-27 key to specify the status of each LCP Vulnerability Assessment. In general, most of the counties subject to sea level rise impacts are covered by vulnerability assessments either updated for sea level rise or mention sea level rise. However, the northern coastal counties have either no vulnerability assessments or the assessments have not been updated for sea level rise.



Source: California Coastal Commission. Sea Level Rise Vulnerability Synthesis. April 17, 2018.

Figure 4-27. Status of Local Coastal Programs Sea Level Rise Vulnerability Assessments
Coastal Areas at Risk of Sea Level Rise

Recommendations

As the implementation of LCP Vulnerability Assessments gains more traction and funding, more coastal communities and counties should have vulnerability assessments updated for sea level rise. In the future, a centralized database through the California Coastal Commission where LCPs can report on the status of Vulnerability Assessments should be developed outside of the Sea Level Rise Vulnerability Synthesis report.

References

California Coastal Commission. 2016. Statewide Sea Level Rise Vulnerability Synthesis. Viewed online at: https://documents.coastal.ca.gov/assets/climate/slr/vulnerability/FINAL_Statewide_Report.pdf

California Coastal Commission. 2015. Sea Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits. Viewed online at: https://documents.coastal.ca.gov/assets/slr/guidance/August2015/0_Full_Adopted_Sea_Level_Rise_Policy_Guidance.pdf

Healthy Economy

Intended Outcome: More benefits from economic activities, including from reduced costs to provide a given level of service (including transaction and permitting costs)

HE 11: Regional Trend in Cost of Water for Municipal and Industrial, and Agricultural Purposes; Cost Compared to State Average for these Same Supplies

This indicator assesses the regional trend in the cost of water for municipal, industrial, and agricultural water use and then further compare the regional costs to the state average. While not inherently a positive or negative sign, increases or decreases in the regional cost of water compared to the statewide average cost of water, could indicate regional economic and water resource issues in California.

Scale:	Regional
Data Sources:	California Public Utilities Commission
Data Availability:	Type II
Metric:	Cost of water to end user (\$/AF or \$/gallon)
Screening Status:	Watershed

Importance and Screening Considerations

Regional trends in the cost of water can be indicative of the economic health of a region. Low supplies of water, such as in a drought, or high water demands can cause water costs to increase. High rates can also be caused due to the real cost to produce water, including energy and treatment costs. These rates may vary regionally. For instance, southern California faces higher costs to convey water from available sources to distance population centers. Water costs may lead to high rates, which in turn can be associated with fewer rate-payers and a potential loss in industrial or agricultural activity.

This indicator is considered a Basic level indicator because the data would be very representative of the intended outcome of identifying the impact of water on economic activities. Comparing to state averages helps adjust for market influencers out of a region's control, such as a statewide drought, and would provide a region-specific snapshot of economic health and encourage investigation into local market indicators. Ultimately, tracking the cost of water for different purposes and comparing the relative trends to other regions would be useful for regional decision makers and planners. However, viable data sources have yet to be developed.

Representative of Outcome:	Medium-High
Data Viability:	Medium
Cost:	Medium-High
Potential Longevity:	High
Supportive of Decision Making:	Medium

Initial Data and Results

No initial data are presented. A potential description of methodology is presented below.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework will continue to develop. The cost of water can face many outside influences, including water availability, demand levels, and energy costs. This indicator would help determine how different region's costs of water are impacted by different stressors, and indicate the success of the region's mitigation of these stressors.

The methodology for this indicator would involve gathering data from local utilities or other entities within a region to determine the average cost of water for municipal, agricultural, and industrial purposes. No centralized, official source of statewide water rate data currently exists. While rates from individual water service providers are available online, this information is not currently tracked or compiled on a statewide basis.

The regional cost of water can be indicative of several different economic drivers, especially when compared with other regions in the state. A regional upward trend could indicate recent investments for infrastructure upgrades to provide future benefits or a lack of supply, such as in dry water years. A regional trend downward could indicate a water supply surplus, which could be indicative of a wet water year. While no target outcome is evident, this indicator would show the regional trends and provide insight into whether regional response to factors such as climate, population, regulatory, or industrial changes are successfully being addressed and negative effects being mitigated in order to foster a healthy economy.

References

Public Policy Institute of California. "California's Water Market." Public Policy Institute of California. Viewed online at: <http://www.ppic.org/publication/californias-water-market/>. Last accessed: February 9, 2018.

Hanak, Ellen and Elizabeth Stryjewski. 2012. California's Water Market, By the Numbers: Update 2012. Public Policy Institute of California. Viewed online at: http://www.ppic.org/content/pubs/report/R_1112EHR.pdf

Healthy Economy

Intended Outcome: More benefits from economic activities, including from reduced costs to provide a given level of service (including transaction and permitting costs)

HE 12: Volume of Water Transferred on the Open Market; Cost of Water on the Transfer Market

This indicator assesses the volume of water transferred on the open market and the associated cost, to evaluate general trends in water transfers. Water transfers involve a change in the place of water use, from the water's historic point of diversion and/or use, to a new location and/or use. Water may be transferred for a variety of purposes, including agricultural, municipal, environmental, and industrial uses.

For the purpose of this indicator, water transferred is considered water that is physically transferred resulting from a trade from one entity to another, through the means of short or long-term leases and sales of water rights. The cost of water is considered the price that the buyer paid, per acre-foot of water.

The target outcome for this indicator is showing an economical open water market that supports flexible allocation and water use in California.

Scale:	Statewide
Data Sources:	State Water Board; DWR; Water Agencies
Data Availability:	Type III
Metric:	Volume of water transfers vs. cost of transfer water
Screening Status:	Basic

Importance and Screening Considerations

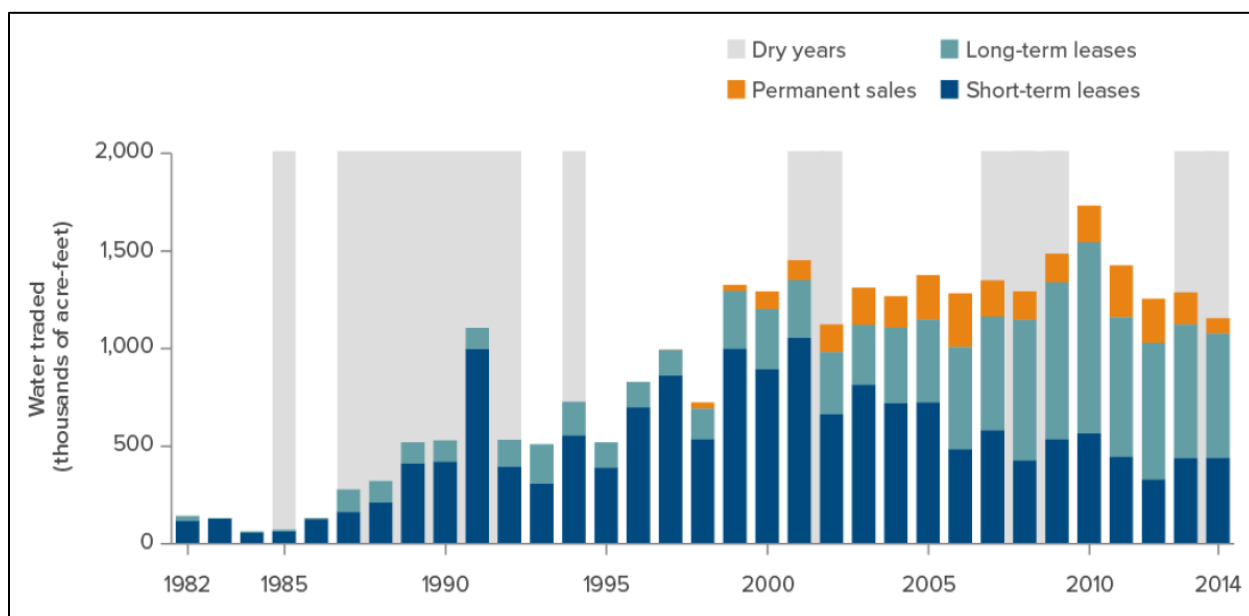
The ability to transfer water on the open market adds flexibility to the state's water supply – helping to address conditions of temporary shortage and to accommodate longer-term changes in demand patterns. Historically, water transfers in California were primarily executed to meet dry-year demands rather than to obtain a primary water supply for agricultural or municipal development. Water transfer demand and completed transfers have increased over time, and consumptive use of water in California has increased. This trend may have an impact on the cost of water transferred on the open market.

This indicator is considered a Basic level indicator. The data for this indicator are useful at a state level to track the overall value of transferred water over time and to determine a willingness to pay for water for various uses. This indicator could also assess the flexibility of California's water resources to changing hydrologic and regulatory conditions, while also evaluating progress in achieving greater regional self-reliance statewide. A majority of the available market information is derived from State agencies with jurisdiction over these transfers, including the State Water Board and DWR.

Representative of Outcome:	Medium
Data Viability:	Medium-High
Cost	Medium
Potential Longevity:	High
Supportive of Decision Making:	Medium

Initial Data and Results

Consistent public data are not currently available for this indicator. Considerable work would be required to compile and analyze the data to provide sufficient information for this indicator. The Public Policy Institute of California (PPIC) has released reports characterizing the California water market that could be used as a step toward the development of this indicator. Reproduced from PPIC's most recent report, Figure 4-28 shows the volume of water transferred on the water market from 1982 through 2014. PPIC gathered information from a variety of sources including the State Water Board, DWR, Reclamation, CALFED Bay Delta Program, records from the CVP and SWP, and the Colorado River Project, as well as directly from other entities, agencies, and sources. The results were then analyzed and adjusted to accurately represent the water actually transferred on the open market. The cost of water was not included in the analysis and would be essential to include for the development of this indicator. A potential description of future methodology is presented in the Recommendations section.



Source: E. Hanak and E. Stryjewski. *California's Water Market Fact Sheet* (PPIC, 2016)

Note: The figure shows water traded between entities that are not members of the same water district or wholesale agency. It excludes volumes committed under long-term lease and permanent-sale contracts that were not physically transferred because of hydrologic conditions or other factors (in 2014, roughly 800,000 acre-feet). Dry years are those classified as critical or dry for the Sacramento Valley.

Figure 4-28. Volume of Water Transferred on the California Water Market 1982-2014

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework will continue to develop. An active transfer market has existed in California for a number of years and can be an effective water management tool to provide much-needed flexibility. However, there is currently no official centralized source for information regarding the volume and cost of water transferred. It is recommended that this be developed.

The proposed methodology for this indicator would be to compile and centralize information from State Water Board, DWR, and other water sellers and buyers on the volume of water transferred annually coupled with the cost of the water transferred, on an annual basis. As described above, a characterization

of the California water market has previously been done by PPIC, and its methodology would serve as a model for data acquisition and analysis. However, additional information on the cost of the water transferred would need to be collected and tracked over time to inform this indicator.

References

- Public Policy Institute of California. “California's Water Market.” Public Policy Institute of California. Viewed online at: <http://www.ppic.org/publication/californias-water-market/>. Last accessed: February 9, 2018.
- Hanak, Ellen and Elizabeth Stryjewski. 2012. California’s Water Market, By the Numbers: Update 2012. Public Policy Institute of California. Viewed online at: http://www.ppic.org/content/pubs/report/R_1112EHR.pdf
- Hanak, Ellen and Elizabeth Stryjewski. 2012. California’s Water Market, By the Numbers: Update 2012: Technical Appendices. Public Policy Institute of California. Viewed online at: http://www.ppic.org/content/pubs/other/1112EHR_appendix.pdf

Healthy Economy

Intended Outcome: More benefits from economic activities, including from reduced costs to provide a given level of service (including transaction and permitting costs)

HE 13: Percent of Average Annual Power Demand Satisfied by Hydropower

This indicator assesses the percent of the statewide average annual power demand is satisfied by hydropower, or hydroelectric power, in California. Currently, hydroelectric power provides about 15 percent of California’s power annually. The amount of hydroelectric power produced varies each year and is largely dependent on rainfall.

Approximately 400 hydroelectric power plants produce electricity in California, often as part of multipurpose dams that also provide water supply, flood control, and/or recreation. The larger hydroelectric power plants on dams in California are operated by Reclamation and DWR. Many smaller hydroelectric power plants are operated by utilities, such as Pacific Gas and Electric Company.

Scale:	Statewide
Data Sources:	California Energy Commission; Reclamation; DWR
Data Availability:	Type I
Metric:	Annual hydroelectric power demand (megawatts)
Screening Status:	Basic

Importance and Screening Considerations

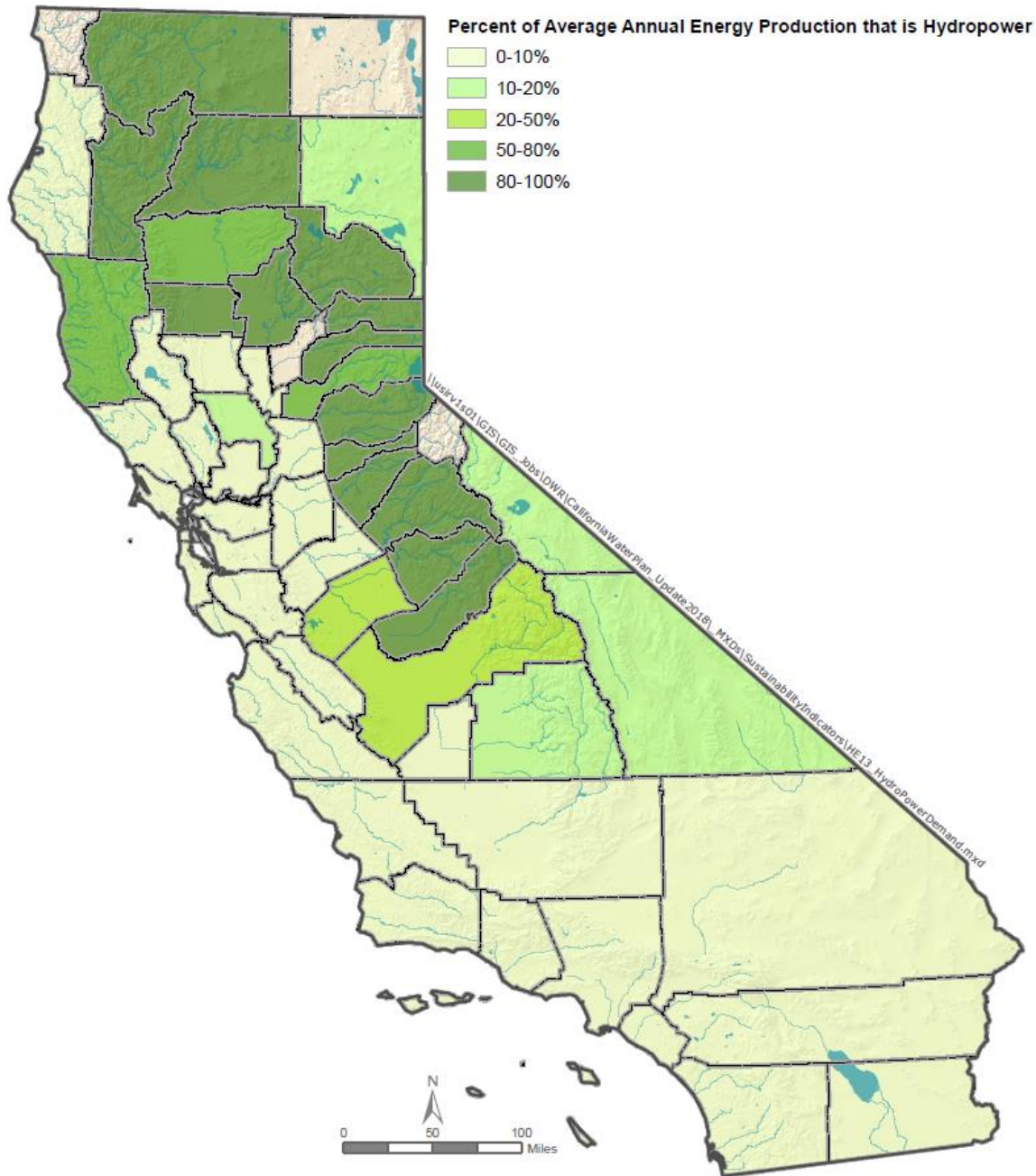
Hydroelectric power benefits include near-zero emissions and a relatively low production cost. The amount of hydroelectric power generated is dependent on rainfall, snowpack, and storage, so this indicator could be indicative of greater issues, such as climate change. Long-term trends leading to changes in precipitation patterns or decreased snowpack or storage would lead to decreased hydroelectric power benefits.

This indicator is considered a Basic indicator. Although, not directly representative of benefits from economic activities, this indicator could be a useful representation of the water-energy nexus statewide. This indicator is easy to apply and understand, and data are readily available. The amount of hydroelectric power produced varies each year and is largely dependent on snow, storage, and rainfall in upper watersheds, so long-term trends would reveal the effects of climate change or varying hydrologic conditions. The data are readily available, but may be held by multiple entities.

Representative of Outcome:	Medium
Data Viability:	High
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

Initial Data and Results

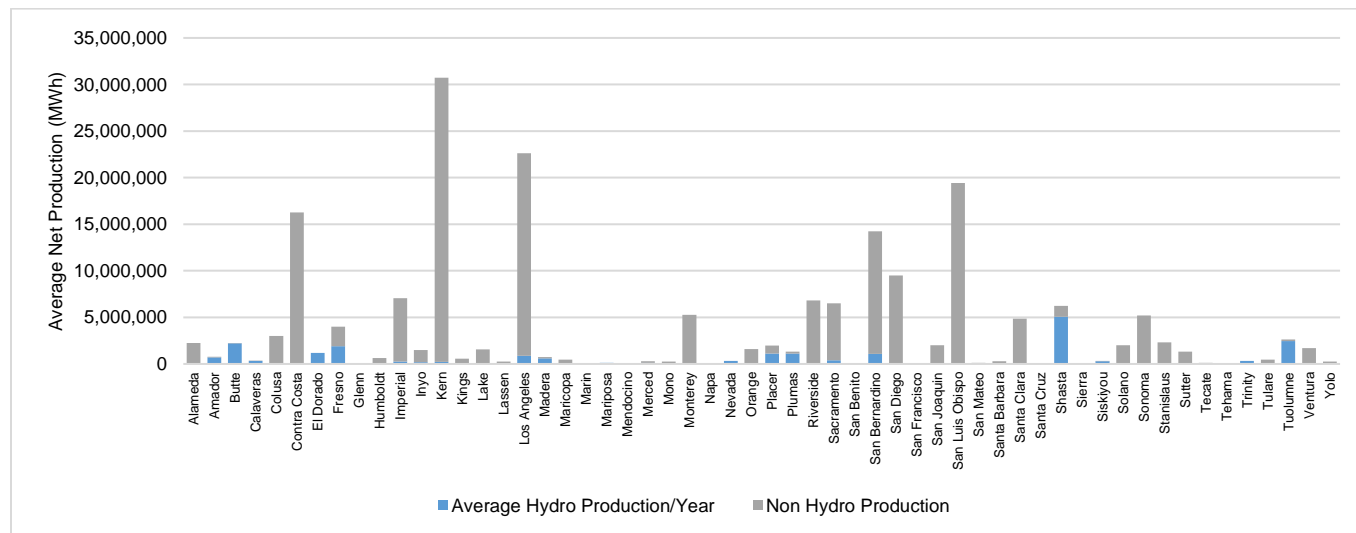
Average annual hydroelectric power production by county were compiled for a five-year period (2013-2016), as collected by the California Energy Commission. Data include both wet years and drought conditions. Figure 4-29 shows the percent of each county's hydroelectric power production that comes from hydropower. Northern California, with more reservoir locations and higher levels of annual precipitation, produces larger amounts of hydroelectric power for the state.



Source: "Energy Maps of California." California Energy Commission. December 20, 2017.

Figure 4-29. Average Hydroelectric Power Percent of Total Annual Power Production from 2013 to 2016

Figure 4-30 shows the total energy production by county, highlighting the portion that is hydroelectric power. Although certain counties have a high percentage of hydroelectric power, the overall amount of hydroelectric power produced annually across the state was about 30 percent on average from 2013 to 2016.



Source: "Energy Maps of California." California Energy Commission. December 20, 2017.

Figure 4-30. Energy Production by County, Annual Average (2013-2016)

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework will continue to develop.

The methodology for developing this indicator will involve compiling annual hydropower production data from all the facilities in the state. Analysis of future periods could be compared to find long-term trends in hydropower generation.

Consideration should be given to indicators better suited for this intended outcome. This indicator does not provide a broad overview of increased economic benefit to multiple economic sectors, despite its current status as the only indicator under its intended outcome.

References

Water Education Foundation. "Hydroelectric Power." Water Education Foundation. Viewed online at: <http://www.watereducation.org/aquapedia/hydroelectric-power>. Last accessed: December 20, 2017.

California Energy Commission. "Energy Maps of California." California Energy Commission. Viewed online at: <http://www.energy.ca.gov/maps/>. Last accessed: December 20, 2017.

Healthy Economy

Intended Outcome: Reduced likelihood or occurrence of significant social disruption following a disaster.

HE 14: Value of Assets within Floodplains with Equal to or Greater than a 1 Percent Chance of Flooding in any Given Year

This indicator assesses the value of assets (built infrastructure) with equal to or greater than 1 percent of flooding in any given year, representing 100-year floodplains, throughout the state. The target outcome for this indicator is to show an increasing trend towards increased and appropriate levels of flood protection.

Scale:	Statewide
Data Sources:	DWR; U.S. Census Bureau; FEMA; Cal OES
Data Availability:	Type I
Metric:	Value (\$)
Screening Status:	Basic

Importance and Screening Considerations

California has experienced destructive flood events throughout its history, and all areas of the state are subject to at least one form of flooding. Every county in California was declared a Federal disaster area at least once for a flooding event in the last 20 years. Most recently, due to heavy storms in January 2017, 34 of California's 58 counties were included in the Federal disaster declaration. The number of Californians and the value of assets exposed to flooding is likely to continue to increase because of increasing population and development in floodplains.

Estimates suggest structures valued at \$575 billion and crops valued at \$7.5 billion are located in areas that have at least a 1 in 500 chance of flooding in any given year. These estimates do not include the impacts of future development, population changes, climate change, or costs due to loss of major infrastructure and critical facilities.

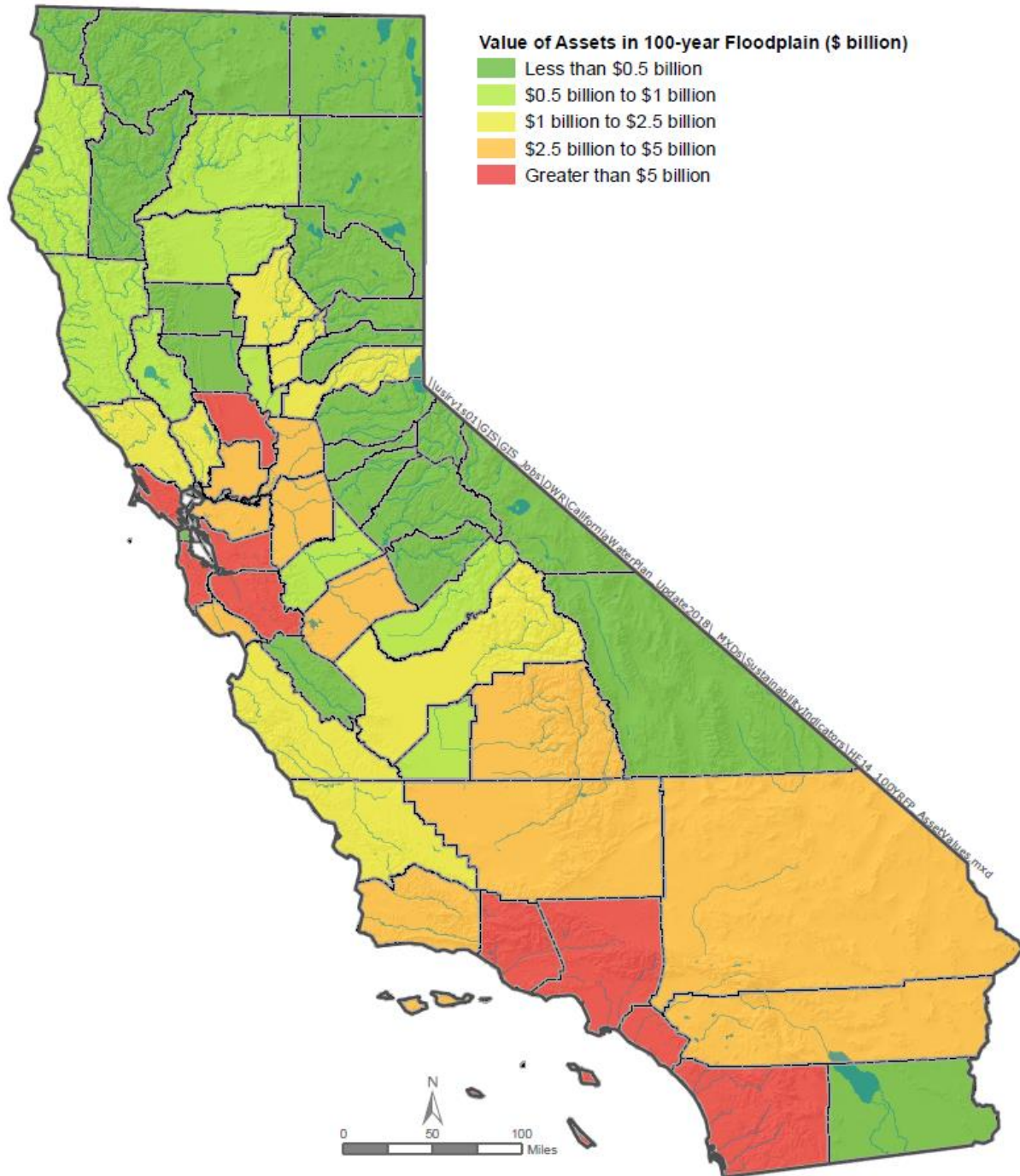
This indicator is considered a Basic level indicator. Determining the value of assets in 100-year floodplains would be supportive of decision making, particularly in combination with indicators related to public safety. Although this indicator is not directly tied to the intended outcome, evaluation of the data would indicate vulnerability to and potential for significant social disruption in different areas around the state.

During initial indicator development, some feedback related to reflecting State requirements for 200-year floodplains in the Central Valley. However, the majority of State and Federal agencies collect data for 100-year floodplains. Data are available from DWR to assess the 200-year floodplains in the Central Valley but not in the rest of the state. Therefore, this indicator was formulated and initially evaluated for 100-year floodplains to achieve as complete statewide coverage as possible.

Representative of Outcome:	Medium-High
Data Viability:	Medium-High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

The SFMPP conducted an in-depth analysis in November 2013 of flood exposure risks throughout California. The methodology used floodplain extents from FEMA and the 2012 CVFPP floodplains along with asset information from the Hazus and ParcelQuest databases. Results are presented for 100-year floodplains to achieve as complete statewide coverage as possible. Figure 4-31 shows the value of exposed assets by county in 100-year floodplains. The total value of exposed assets statewide in the 100-year floodplains was estimated at \$142 billion. The value of agricultural lands was 4 percent of this total. Santa Clara, San Mateo, and Orange counties had the highest value of structures exposed to flood risk, each with exposed asset values over \$10 billion. San Joaquin, Fresno, Kern, King, and Merced counties each have over \$350 million in crops exposed to flood risk.



Source: Statewide Flood Management Planning Program – Attachment F: Flood Hazard Exposure Analysis. California Department of Water Resources.

Figure 4-31. Value of Exposed Assets, Including Structures and Contents and Agricultural Crops, in the 100-Year Floodplains

Recommendations

Flood disasters are an unfortunate reality in California. This indicator helps provide decision and policy makers with an outlook to measure what investments or actions may help manage flood disasters and reduce the impacts of flooding. Investments or actions made now will help prevent spending billions more to recover from the effects of this inevitable future flooding.

The results of this indicator should provide the State with a useful way to indicate how much infrastructure is already built and continues to be built in floodplains statewide. Currently, the results may show upward or downward trends in the value of assets in floodplains. This could help inform State investments in flood risk mitigation and/or identify the need for voluntary or regulatory controls. However, the future methodology should account for analyses of assets outside appropriate levels of protection rather than considering a single level of protection for all assets. For example, 200-year floodplains are a State requirement in the Central Valley and could be used for that area. This would better account for both the state's vulnerability to flooding and the potential for social disruption post-flooding.

The future methodology for the indicator should assess the exposure of different classes of assets in the varying floodplains. Crops may only require a 100-year level of protection, while highly urbanized areas may require a 200-year or 500-year level of protection. Future analysis should account for this variation. In addition, floodplain data from the multiple State and Federal agencies should be compiled and reconciled to provide the most recent floodplain extents. In some areas of the state, additional surveying should be conducted to update floodplain data.

References

California Department of Water Resources and U.S. Army Corps of Engineers. 2013. California's Flood Future Highlights. Viewed online at:
https://www.water.ca.gov/LegacyFiles/sfmp/resources/ca_flood_future_highlight.pdf

California Department of Water Resources. 2016. Statewide Flood Management Planning Program Attachment F: Flood Hazard Exposure Analysis. California Department of Water Resources.

California Department of Water Resources. "Central Valley Flood Protection Plan." California Department of Water Resources. Viewed online at: www.water.ca.gov/cvfmfp. Last accessed: February 6, 2018.

Opportunities for Enriching Experience

Intended Outcome: Preserved or enhanced culturally or historically significant sites and communities, including continued and enhanced access to water and land used for sacred ceremonies or cultural practices

OEE 1: Number of Historically and Culturally Significant Sites at Risk of Flooding or Sea Level Rise

This indicator assesses the number of qualified historical buildings, historical sites, and tribal lands with equal to or greater than a 1 percent risk of flooding in any given year. This indicator also includes historical and cultural resources at risk of flooding from sea level rise, of greater relevance in coastal regions throughout California.

This indicator is meant to show geographically where there are historically and culturally significant sites at risk of flooding or sea level rise. The target outcome for this indicator would be zero historically and culturally significant sites at risk of flooding or sea level rise.

Scale:	Statewide
Data Sources:	National Register of Historic Places (NRHP); NOAA; CVFPP
Data Availability:	Type II
Metric:	Number of historical and cultural resources
Screening Status:	Basic

Importance and Screening Considerations

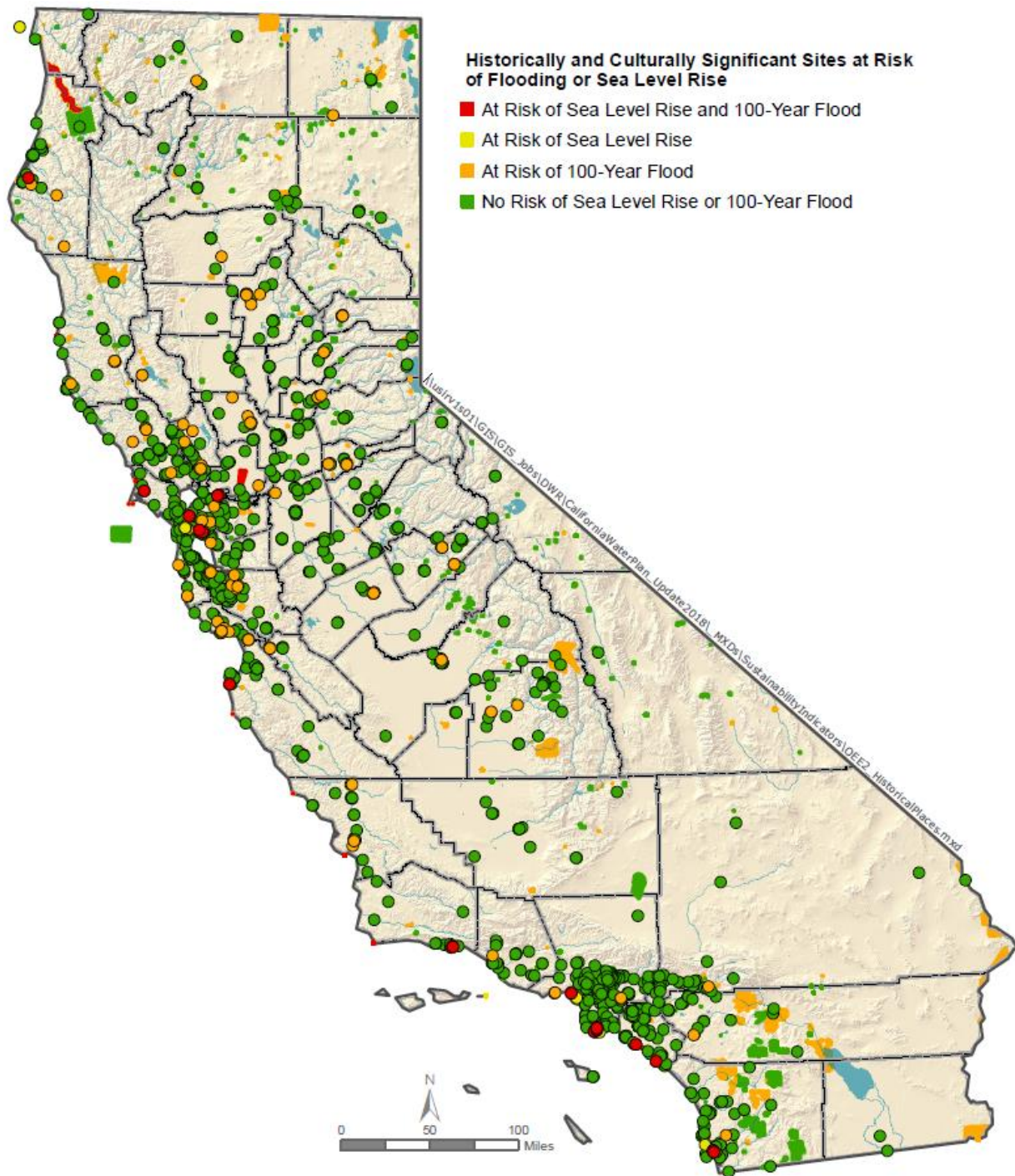
California is rich with historical and cultural resources that represent the contributions and collective human experiences of a diversified population spanning thousands of years. Preserving and protecting these historical and cultural resources continues to enhance the quality of life for many Californians as they provide continuity with the state's history.

This indicator is considered a Basic level indicator. There is information on historical resources in California through the NRHP and tribal lands can be accessed from the DWR Water Plan database. The NRHP is the nation's official list of buildings, structures, objects, sites, and districts worthy of preservation because of their significance in American history, architecture, archeology, engineering, and culture. Historical resources will remain protected by the State, but the State is unable to control flood events or flooding due to sea level rise. This indicator will be indicative of the policies or regulations that may need to be developed to better protect California's historical and cultural sites as climate change and flood events continue to threaten those sites.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Low-Medium
Potential Longevity:	High
Supportive of Decision Making:	Medium-High

Initial Data and Results

The initial data to develop this indicator were gathered from multiple entities including 100-year floodplain extents developed for the CVFPP, NOAA sea level rise data, and the NRHP. Tribal lands data were gathered from DWR's Water Plan database. As shown in Figure 4-32, each historical resource registered on the NRHP and tribal lands in California were assessed based on the corresponding location in the 100-year floodplain extents developed for the CVFPP or the extent of sea level rise. For the purposes of this indicator, the 3 feet above average high tides NOAA sea level rise scenario was evaluated, as well as the hydrologically "unconnected" low lying areas that may also flood from a 3-foot sea level rise scenario.



Sources: "National Register for Historical Places." National Park Service. December 14, 2017.
 Statewide Flood Management Planning Program – Attachment F: Flood Hazard Exposure Analysis.
 California Department of Water Resources.
 Sea Level Rise Viewer. National Oceanic and Atmospheric Administration. February 9, 2018.

Figure 4-32. Number of Historically and Culturally Significant Sites at Risk of Flooding or Sea Level Rise Impacts

As demonstrated in Table 4-14, almost 16 percent of California’s registered historical and cultural resources (including buildings, structures, districts, and sites) are at risk of sea level rise impacts and flooding. Sea level rise poses less of a risk to California’s historical resources than the 100-year floodplain extent, particularly in the Central Valley (as shown in Figure 4-32) where more sites are at risk of flooding when compared to the rest of the state.

Table 4-14. California Qualified Historical and Cultural Resources at Risk of Sea Level Rise Impacts and Flooding

Risk	Number of Historical and Cultural Resources	Percent of Historical and Cultural Resources
Sea Level Rise	145	5.6%
100-year Floodplain	261	10.1%
Total (Statewide)	2,584	15.7%

Sources: “National Register for Historical Places.” National Park Service. December 14, 2017.

Statewide Flood Management Planning Program – Attachment F: Flood Hazard Exposure Analysis. California Department of Water Resources.

Sea Level Rise Viewer. National Oceanic and Atmospheric Administration. February 9, 2018.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

Significant investments have been made in the state’s flood protection system, including levees and bypasses. Flooding occurs in all regions of the state in different forms and at different times. The analysis of how many historical and cultural sites are at risk of flooding and sea level rise will provide information where more enhanced flood protection may be needed to protect California’s historical and cultural sites.

It is recommended to focus this indicator on historical buildings, historical sites, and tribal lands, excluding the assessment of recreational areas. Recreational areas and historical sites serve different purposes for the state of California. The evaluation of recreational areas is already considered under a different set of indicators, including *OEE 2, Change in Natural Area* and *OEE 6, Change in Visitor Days at Water Related Park Lands*. Although CDFW-classified lands evaluated in *OEE 2* are not all recreational areas, the open space or natural areas would support enriching experience for Californians.

References

California Department of Water Resources. “Central Valley Flood Protection Plan.” California Department of Water Resources. Viewed online at: www.water.ca.gov/cvfmfp. Last accessed: February 6, 2018.

National Oceanic and Atmospheric Administration. Sea Level Rise Viewer. Viewed online at: <http://bit.ly/2Etz45E>. Last accessed: February 9, 2018.

U.S. Department of the Interior, National Park Service. “National Register of Historical Places.” National Park Service. Viewed online at: <https://www.nps.gov/nr/>. Last accessed: December 14, 2017.

Opportunities for Enriching Experience

Intended Outcome: Preserved and increased natural areas with aesthetic or intrinsic value (including view shed)

OEE 2: Change in Natural Area

This composite indicator assesses the change in acreage of natural areas including open space, lands in conservation for habitat and other conservation purposes, and lands protected under the California Land Conservation Act of 1965 (LCA or Williamson Act) enrollment.

The LCA enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use. The act serves as an important tool to allow landowners to resist development pressures. Outside of agricultural lands, CDFW is responsible for over 1,100,000 acres of fish and wildlife habitat, managed through 749 properties throughout the state. These properties provide habitat for a rich diversity of fish, wildlife, and plant species and comprise habitats from every major ecosystem in the state. These properties also provide many opportunities for the public to hunt, fish, view wildlife, and learn about nature.

Additional work is needed to explore appropriate target outcomes for this indicator. The target outcome for this indicator could (1) focus on maintaining a trend (increase in natural acreage of no less than 1% averaged over a 10-year period, or maintenance of current natural land area over time with no net decreases over a 10-year period), or (2) establish a specific target (achieving a certain number of acres of natural land area in the State over the next 50 years). The intended outcome associated with this indicator is “preserved and increased natural areas with aesthetic or intrinsic value,” which may make a trend-based outcome more appropriate.

Scale:	Statewide
Data Sources:	CDFW; California Department of Conservation
Data Availability:	Type I-III
Metric:	Acreage
Screening Status:	Basic

Importance and Screening Considerations

Open spaces, such as parks, playgrounds, and natural areas, can provide many health, cultural, recreational, and economic benefits to communities. In addition, California’s open spaces and natural areas provide habitat for thousands of species of plants and animals, many found only in this state. They can also provide important water management functions, supporting water quality, flood management, and groundwater recharge. As the State’s population continues to increase, development is a threat to the preservation of natural areas.

This indicator is considered a Basic level indicator. The initial data and results evaluation is limited to data from CDFW and California Department of Conservation. The data from CDFW provides a comprehensive evaluation of CDFW owned and operated natural areas and conservation easements, while the data from the California Department of Conservation on LCA enrollment focuses on the evaluation of agricultural lands conserved. There may be data available from other sources, including California Coastal Commission, California Department of Parks and Recreation, California State Lands

Commission, Federal Lands, and local parks, to provide a more complete dataset to represent this composite indicator. This indicator would help assess policies enforced by the LCA and provide information appropriate for making policy decisions related to natural areas.

Representative of Outcome:	High
Data Viability:	Medium-High
Cost:	Low-Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

The initial data and results for this indicator are represented by the acreage of land enrolled under the LCA and the acreage of lands under conservation designated by CDFW.

The LCA is a California State statute administered by local governments. The California Department of Conservation releases an annual status report that details the acreage of land in each county that is enrolled under the LCA program. Enrollment statistics are submitted annually as part of the Open Space Subvention application process. From the 2016 Status Report, 52 counties out of 58 counties in California have executed contracts under the LCA program. In addition to LCA contracts, areas can enroll land as Farmland Security Zones. There are 25 counties that have enrolled land under the Farmland Security Zones program.

Table 4-15 presents the statewide reported acreage of lands enrolled under the LCA program for the 2014 and 2015 years, which are the most recent available data sets. Overall enrollment in the LCA program increased slightly from 2014 to 2015.

Table 4-15. Statewide Reported Acreage under the Land Conservation Act and Farmland Security Zones

Statewide Reported Acreage (Acres)		
Category	2014	2015
Prime	4,627,349	4,591,784
Non-Prime	9,064,550	9,278,691
Prime – Farmland Security Zone	797,275	786,538
Non-Prime – Farmland Security Zone	80,396	79,817
Other – Farmland Security Zone	61,289	57,613
Total	14,630,859	14,794,443

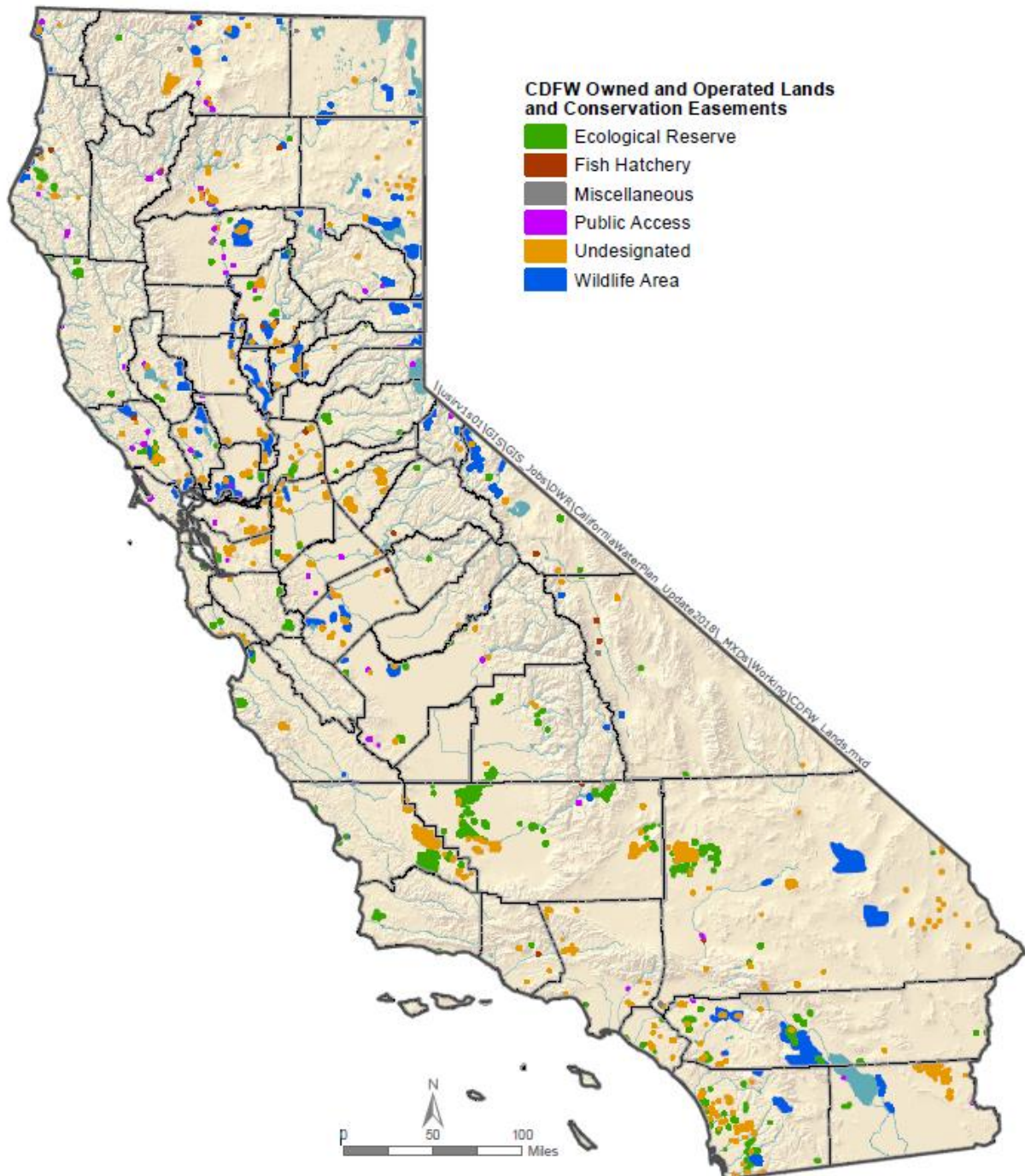
Source: *The California Land Conservation Act of 1965 2016 Status Report*. California Department of Conservation. 2016.

For non-agricultural lands, CDFW inventories the acreage of lands classified as wildlife areas, ecological reserves, undesignated lands, public access, fish hatcheries, or miscellaneous lands. Table 4-16 presents the number of properties and the total acreage of each classified type of land. Figure 4-33 geographically represents these lands.

Table 4-16. California Department of Fish and Wildlife Classification of Lands

Classification	Number of Properties	Total Acreage
Wildlife Areas	111	709,508
Ecological Reserves	136	228,906
Undesignated Lands	315	222,768
Public Access	127	4,080
Fish Hatcheries	21	833
Miscellaneous Lands	39	105
Total	749	1,166,201

Source: "CDFW Lands Inventory Fact Sheet." California Department of Fish and Wildlife. January 26, 2018.



Sources: "CDFW Lands Inventory Fact Sheet." California Department of Fish and Wildlife. January 26, 2018.

Figure 4-33. California Department of Fish and Wildlife Owned and Operated Lands and Conservation Easements (as of January 2018)

Some counties throughout the state have more CDFW owned and operated lands and conservation easements than others, which is likely influenced by the natural terrain and geography of each county. Table 4-17 presents the top 10 counties that have the highest percentage of lands in conservation classified by CDFW.

Table 4-17. Top 10 Counties in the State that have the Highest Percentage of Lands Classified by California Department of Fish and Wildlife

County	Percent of Land Classified by California Department of Fish and Wildlife
Napa	6.87%
Yuba	5.69%
Solano	4.82%
Yolo	4.45%
Butte	4.17%
Marin	3.77%
Riverside	3.20%
San Luis Obispo	3.13%
Sierra	2.86%
Sacramento	2.81%

Source: "CDFW Lands Inventory Fact Sheet." California Department of Fish and Wildlife. January 26, 2018.

Recommendations

This indicator is a composite indicator. In order for natural area to be completely evaluated, data are needed from multiple sources including, but not limited to, California Coastal Commission, California Department of Conservation, CDFW, California Department of Parks and Recreation, California State Lands Commission, Federal Lands, and local parks. However, each entity may not maintain all the information on acreage of open space and natural lands conserved or maintained. Presently, this indicator only assesses lands enrolled in the LCA program and CDFW classified lands. Although local governments are not mandated to participate in the LCA and this may create potential data gaps, the California Department of Conservation releases a status report that details the acreage of land in each county that is enrolled under the LCA. Similarly, CDFW maintains a database of the acreage of classified lands.

In the future, data outside the CDFW classified lands and LCA program enrollment should be considered to create a more complete and comprehensive evaluation of natural areas in California. A map should be developed that not only includes CDFW classified lands, but also would include lands enrolled under the LCA program and other natural areas assessed under the additional sources mentioned above. There is potential overlap of natural areas, so displaying one map with all the different natural area types may not be feasible.

References

California Department of Fish and Wildlife. "CDFW Lands Inventory Fact Sheet." California Department of Fish and Wildlife. Viewed online at: <https://www.wildlife.ca.gov/Lands/Inventory>. Last accessed: January 26, 2018.

California Department of Conservation. 2016. The California Land Conservation Act of 1965 2016 Status Report. Viewed online at: http://www.conservation.ca.gov/dlrp/lca/stats_reports/Documents/2016%20LCA%20Status%20Report.pdf

Opportunities for Enriching Experience

Intended Outcome: Continued and enhanced access to resources that support education and learning

OEE 3: Number of School Districts Using Water and Environmental Curriculum in K-12 Programs

This indicator assesses the number of school districts that incorporate water-related curriculum in kindergarten through grade 12 programs. DWR is working towards implementing water-related curriculum in school districts statewide. DWR Water Education and Outreach Branch works to educate the public about water issues through educator workshops, special events, and other outreach activities. The Water Education Program assists California's formal and informal educators by supporting professional development for K-12 educators, providing materials such as worksheets, posters, and workbooks, and attending educational events throughout the state.

The target outcome for this indicator would show the majority or all of the school districts implementing water-related curriculum in their K-12 grades.

Scale:	Statewide
Data Sources:	California Department of Education; DWR Project WET; Water Education Foundation
Data Availability:	Type II
Metric:	Number of School Districts
Screening Status:	Basic

Importance and Screening Considerations

This indicator could provide information on where water and environmental studies are incorporated into grade school curriculum. This allows young students to develop foundations in science curriculum based on their state's water resources. These foundations may lead students to make decisions to pursue water resource management careers or impact individual knowledge of the significance of water in California.

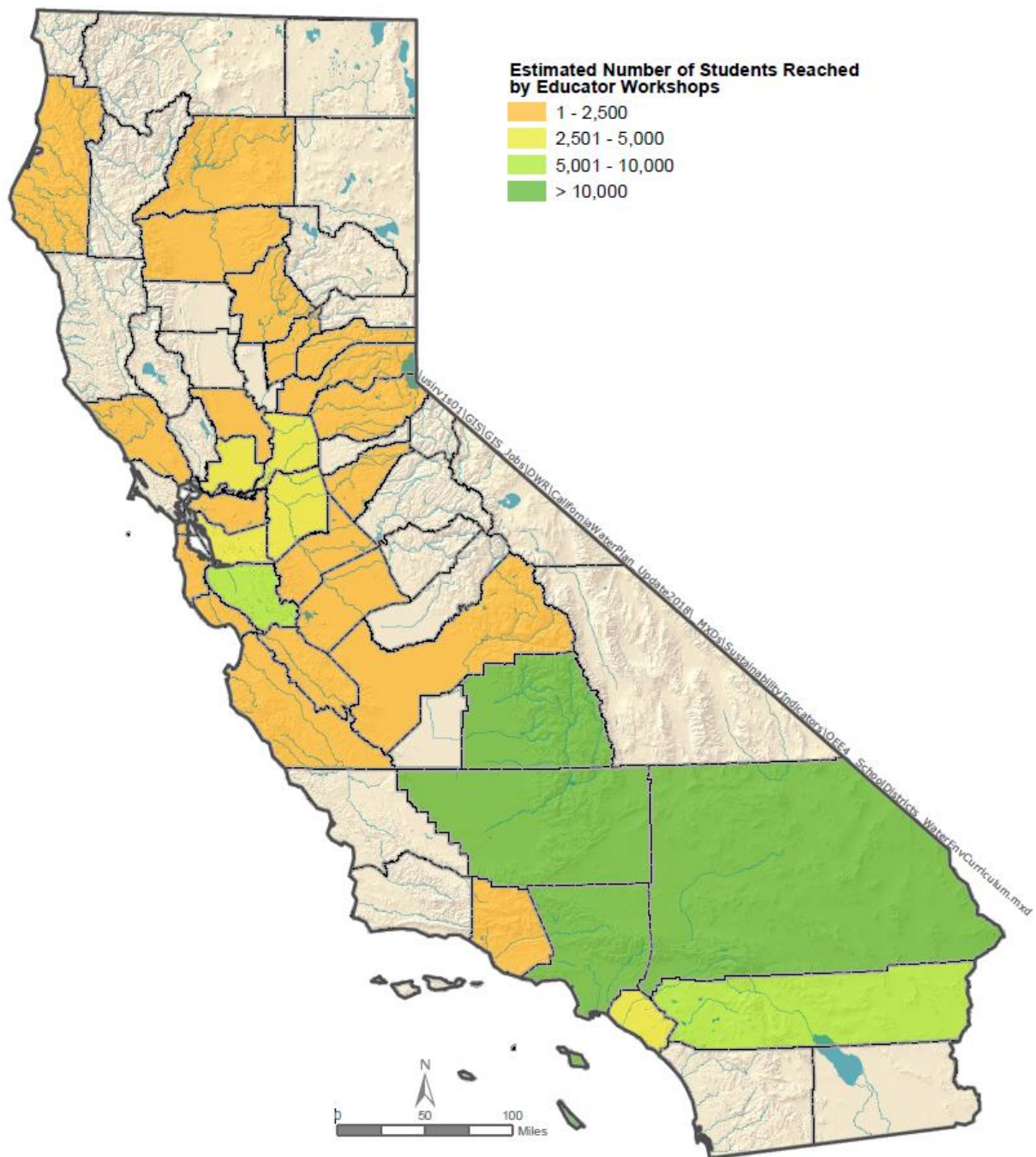
This indicator is considered Basic level. This indicator is easy to understand and would be easy for different regions and watersheds throughout the state to develop. Information on public school curriculum could be gathered from the California Department of Education. In addition, the DWR Public Affairs Office Water Education Branch collects data on the estimated number of students reached through their outreach events.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	High

Initial Data and Results

While a comprehensive data source is lacking, initial data on students reached through DWR's Public Affairs Office Water Education Branch in 2016 are presented in Figure 4-34. The estimated number of students reached represents the estimated impact of educators who attended various programs and events through the School Education Program Workshops, the Floodplain & Climate Divisions Workshops, DWR Water Education Committee Member and California State Water Contractors Sponsored Workshops, the CEEF Institute, the Delta Studies Institute, and the Salmonid Workshop.

These workshops are concentrated in certain areas of California. For example, the Bay Area, Los Angeles, and the southern Central Valley have had a high number of local workshops for educators, while other areas of the state have had little outreach through DWR workshops. Therefore, the majority of K-12 students that have been reached are within those areas or in neighboring counties.



Source: Schultz K. Feb. 5, 2018.

Figure 4-34. Estimated Number of Students Reached by California Department of Water Resources Educator Workshops

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

Additional data from a wider range of program would be necessary to continue developing this indicator and providing a more comprehensive picture of where water and environmental curriculum is used to teach students. This should include accessing curriculum for private schools or smaller school districts throughout the state. Local programs to bring water and environmental curriculum to classrooms are not captured using the current data sources. Additional sources would need to be developed. Development of future data sources should be considered by DWR's Water Education Branch.

References

Schultz K, Water education specialist, Water Education Branch, California Department of Water Resources, Sacramento (CA). Feb. 5, 2018 – email correspondence with Marshall P, Principal Engineer, Stantec, Sacramento (CA).

Opportunities for Enriching Experience

Intended Outcome: Continued and enhanced access to resources that support education and learning

OEE 4: Number of Students Enrolled in Water and Environmental Resources Management Programs Within the UC and CSU Systems

This indicator assesses the number of students enrolled in water and environmental resources management programs within the UC and California State University (CSU) systems. Campuses throughout the CSU and UC system educate students and prepare them for careers in various industries and fields related to water and natural resources. The target outcome for this indicator would show stable or growing numbers of both Bachelor's and post-graduate awards across all UC and CSU schools in water-related or natural resource programs.

Scale:	Statewide
Data Sources:	National Center for Education Statistics (NCES)
Data Availability:	Type I
Metric:	Number of students enrolled in water-related programs
Screening Status:	Basic

Importance and Screening Considerations

Educational programs related to water and environmental resources management in California is vital to filling future technical, policy, or leadership roles associated with water resources management in California. High enrollment rates in higher-education programs associated with water and environmental resources management would indicate continued access to water-related resources that support education throughout the state.

This indicator is considered a Basic level indicator. Data and statistics on enrollment of students in water-related or natural resource programs are easily accessible through a centralized National Center of Education Statistics database. The evaluation of this indicator may be more applicable at a state than a local level due to the locations of the UC and CSU schools.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

Initial Data and Results

The initial methodology for this indicator involved using information from the centralized NCES database to track trends in education related to water and natural resource programs in UC and CSU schools. Available data include the number of awards presented to students in program categories and majors by universities. Initial data on the number of awards conferred for the 2015-2016 academic year, the most current data, for Californian 4-year public universities are shown in Figure 4-35. Awards were counted for all programs in NCES's Natural Resources and Conservation category as well as for the Environmental Engineering and Hydrology and Resources Science majors. Total awards include

certificates, Bachelor's degrees, Master's degrees, and Doctorate degrees. The number of students enrolled in these programs represent low percentages of total university enrollment.



Source: College Navigator. National Center for Education Statistics. October 30, 2017.

Figure 4-35. Number of Awards from Water and Environmental Resources Management Programs in University of California and California State University Systems and Four-year Public Universities

While the number of students enrolled in water and environmental resources management programs is low at individual schools, a spread of programs is available throughout the state, often centered on urbanized areas.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. Trends would need to be tracked by gathering data on the number of students currently enrolled in a water or natural resource related major or program over time.

References

National Center for Education Statistics. College Navigator. Viewed online at:
<https://nces.ed.gov/collegenavigator>. Last accessed: October 30, 2017.

Opportunities for Enriching Experience

Intended Outcome: Continued and enhanced access to resources that support education and learning

OEE 5: Number of Water Agencies that Have Educational Programs for Customers

This indicator assesses the number of water agencies that offer educational programs for their customers. Many water districts and agencies throughout California are actively involved in educating their customers on the importance of water quality, water use efficiency. Some programs are implemented in local school districts, while other programs are more community oriented and focus on raising awareness of water efficiency programs and activities.

The target outcome for this indicator would be that every water agency or district is performing some sort of community education or outreach program to inform their customers of relevant water issues or topics.

Scale:	Statewide
Data Sources:	Local Water Agencies
Data Availability:	Type II
Metric:	Number of Water Agencies
Screening Status:	Basic (Future)

Importance and Screening Process

Water agencies and districts should promote discussion and educational activities for regional water use efficiency issues. By promoting educational programs for customers, water agencies and districts can provide focus on community participation around regional water policy issues, clearly communicate regional water policy issues to key constituent groups, and provide opportunity for participation and collaboration with other relevant member agencies.

This indicator is considered a Basic (Future) level indicator. This indicator will provide interpretation of the intended outcome on a watershed scale, as most water agencies and districts are focused on a more regional level, rather than statewide. However, no centralized data source currently exists.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	High

Initial Data and Results

No initial data are presented. Recommendations to gather data from existing highly dispersed sources or to build a centralized database are presented below.

Recommendations

This indicator is considered a Basic (Future) level indicator, so the guidelines and framework for measuring the indicator will continue to develop. Individuals should develop an understanding of water

resources systems, especially at a local level. Conservation and efficiency efforts are typically enforced on a local or regional level, so water agencies and districts are the appropriate parties to promote education on various water topics.

The methodology for this indicator would involve gathering information from water districts and agencies on what community education programs they offer. The community education programs promoted by water agencies in school districts should also be considered as part of this indicator.

Currently, no data have been collected for this indicator. A full list of water agencies or districts is not available, although partial lists exist as part of membership in the Association of California Water Agencies or as a utility regulated by the California Public Utilities Commission. This indicator may also need to consider urban water suppliers that submit Urban Water Management Plans and public water systems. Once a list of agencies has been established, then information on the community education programs offered by each would need to be gathered. This effort would require a set of criteria to qualify programs or materials. Agencies, districts, systems, and suppliers could potentially be surveyed to provide information for this indicator.

References

California Public Utilities Commission. "Water Division." California Public Utilities Commission. Viewed online at: <http://www.cpuc.ca.gov/water/>. Last accessed: January 26, 2018.

California Water Association. "Regulated Water Utilities in California." California Water Association. Viewed online at: <http://www.calwaterassn.com/about-cwa/regulated-water-utilities-in-california/>. Last accessed: January 26, 2018.

Association of California Water Agencies. "Member Directory." Association of California Water Agencies. Viewed online at: <https://www.acwa.com/about/members-associates-affiliates/>. Last accessed: January 26, 2018.

Opportunities for Enriching Experience

Intended Outcome: Continued and enhanced recreational opportunities in waterways, reservoirs, or natural and open spaces

OEE 6: Change in Visitor Days at Water Related Park Lands

This indicator assesses the change in visitor days at water related park lands, including all local, State, and Federal parks. Park lands can help provide health, inspiration, and education to the people of California by creating opportunities for high-quality outdoor recreation. The target outcome for this indicator would be no change or an increase in visitor days at park lands throughout California over time.

Scale:	Statewide
Data Sources:	California Department of Parks and Recreation
Data Availability:	Type III
Metric:	Change in number of visitor days
Screening Status:	Basic

Importance and Screening Considerations

California boasts a high diversity of State and National Parks. Some of the most notable National Parks include Yosemite, Sequoia, and Joshua Tree National Parks. The State Park System over 340 miles of coastline as well as 970 miles of lake and river frontage. These parks provide opportunity for visitors to enjoy water-related recreational activities.

Tracking visitation data for these parks can help quantify if recreational opportunities are accessible and attractive to visitors. Data are collected annually by the State Park System and the National Park System. Local parks may not have the same level of data.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Initial Data and Results

Initial data were drawn from visitation reports produced by the National and State Park Systems.

The following locations were included in this analysis as water-related park lands in the National Park System: Golden Gate National Recreation Area (NRA), San Francisco National Historic Place (NHP), Point Reyes National Seashore, Fort Point National Historical Site, Muir Woods National Monument (NM), Cabrillo NM, Santa Monica NRA, Whiskeytown NRA, Redwoods National Park, Channel Islands National Park, Rose the Riveter WWII Home Front, Part Chicago Naval Magazine NM. These locations are either along the coast, or inland with a major water feature. Table 4-18 shows the number of visitors to each of these locations in 2015 and 2016.

The State Park System provides waterfront footage for all parks as part of its Annual Statistical Report. Visitors to parks with waterfront footage in each State Park System District are shown in Table 4-19.

Table 4-18. Visitors to Water-Related National Parks in 2015 and 2016

Park Name	2015	2016
Golden Gate NRA	14,888,537	15,638,777
San Francisco Maritime NHP	4,173,014	4,334,752
Point Reyes NS	2,501,106	2,438,442
Fort Point NHS	1,610,466	2,264,154
Muir Woods NM	1,099,923	1,123,121
Cabrillo NM	981,825	959,145
Santa Monica Mountains NRA	797,126	906,606
Whiskeytown NRA	843,845	875,565
Redwood NP	527,143	536,297
Channel Islands NP	324,816	364,807
Rosie The Riveter WWII Home Front	56,362	64,425
Port Chicago Naval Magazine NM	963	1,942

Source: "Reports." National Park Service Visitor Use Statistics. January 30, 2018.

Key:

NHP = National Historic Place

NM = National Monument

NRA = National Recreation Area

Table 4-19. Number of Visitors During 2015-2016 Fiscal Year to California State Parks with Waterfront Footage

State Park System District	Number of Visitors to Parks with Water	Number of Parks with Water not Tracking Visitors	Number of Parks with Water
Angeles	1,736,711	5	10
Bay Area	1,792,628	4	11
Capital	-	0	0
Central Valley	1,181,570	1	9
Channel Coast	2,054,459	2	9
Colorado Desert	495,645	0	3
Gold Fields	1,836,075	4	8
Inland Empire	507,833	0	1
Monterey	5,021,482	1	16
North Coast Redwoods	2,136,194	1	19
Northern Buttes	1,740,341	2	11
Oceano Dunes	2,050,235	0	2
Ocotillo Wells	-	0	0
Orange Coast	9,051,173	1	7
San Andreas	-	0	0
San Diego Coast	8,887,729	2	10
San Luis Obispo Coast	3,146,764	1	7
Santa Cruz	7,805,344	4	21
Sierra	1,919,800	2	11
Sonoma-Mendocino Coast	7,430,157	0	18
Tehachapi	860,592	0	2
Twin Cities	-	0	0

Source: Statistical Report 2015-2016 Fiscal Year. California State Parks. 2016.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop. Further work to develop a visual representation of this indicator may show trends in what regions of the state are most affected by impacts from changing climactic conditions on recreational opportunities. An effective way to visually represent this indicator would be a statewide map that would show the percent change by location over a number of years.

If data on local parks are desired, a central database for these parks to provide visitation data to would need to be developed. However, collecting visitation data may remain a problematic aspect of this indicator. Therefore, identifying key locations where trends in hydrologic conditions are most evident through visitation rates may be most useful to guide decision makers.

Therefore, future methodology should establish key locations across the state to track visitation or a set of criteria to determine what parks are included in “Water Related Park Lands.” Additional types of recreational areas may also need to be considered through this indicator, potentially including snow-related or hunting-related recreation. Both these types of recreation, while potentially not covered within park systems, are often impacted by hydrological conditions.

References

California State Parks. 2016. Statistical Report 2015-16 Fiscal Year. Planning, Recreation and Support Section Marketing and Business Development Office. Viewed online at:

<https://www.parks.ca.gov/pages/795/files/15-16%20Statistical%20Report%20FINAL%20ONLINE.pdf>

U.S. Department of the Interior, National Park Service. “Reports.” National Park Service Visitor Use Statistics. Viewed online at: <https://irma.nps.gov/Stats/Reports/Home>. Last accessed: January 30, 2018.

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5 Advanced Sustainability Indicators

This section provides summaries of each sustainability indicator that was considered Advanced level as a result of the screening process. Table 5-1 lists all 7 indicators that will not be used for the 2018 pilot studies, but should be considered for use in future California Water Plan updates.

Each assessment of the Advanced sustainability indicators provides the description, importance, insight on the screening process, recommendations, and any references that were utilized. The indicators are divided by each societal value (Public Health and Safety, Ecosystem Vitality, Healthy Economy, and Opportunities for Enriching Experiences) and then further divided by their corresponding intended outcome. Some of the intended outcomes didn't have any indicators that were considered Advanced.

Table 5-1. Comprehensive List of Intended Outcomes and Each Associated Indicator that are Advanced Level

Ref No.	Public Health and Safety
A reliable water supply for domestic needs, sanitation, and fire suppression.	
1	Water Supply Vulnerability to Wildland Fires
2	Percent of Urban Fire Water Systems that Pass 5-year Mandated Inspections
Ecosystem Vitality	
Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.	
3	Deviation from Unimpaired Flows
4	California Integrated Assessment of Watershed Health
5	Number of Fish Rescues to Fish Kills and Fisheries Closed to Recreational and Commercial Activity
6	Forest Health
Achieved designated beneficial uses for water bodies throughout the state	
7	Number of Fish Consumption Advisories
Healthy Economy	
Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply.	
8	Real Cost of Water to End User
9	Watershed Drought Response Capacity Index
Opportunities for Enriching Experiences	
Continued and enhanced recreational opportunities in waterways, reservoirs, or natural and open spaces.	
10	Average Distance to Water-Related Recreational Resources

Public Health and Safety

Intended Outcome: A reliable water supply for domestic needs, sanitation, and fire suppression.

PHS: Water Supply Vulnerability to Wildland Fires

This indicator would assess the threat and vulnerability of water supply or water supply systems to wildland fires in California. California is made up of wildfire-prone and fire-adapted landscapes. Natural wildfire has supported ecosystem health and is critical to maintaining the structure and function of ecosystems. However, wildfire poses a significant threat to life, public health, infrastructure and other property, and natural resources.

This composite indicator could take into account multiple factors defined by California Department of Forestry and Fire Protection's (CalFire) Fire and Resource Assessment Program (FRAP), including fire trends, fire threats, fire security, historical wildfire activity, post-fire erosion threat levels, and Fire Return Interval Departure (FRID). The FRAP is required by the California legislature to produce periodic assessments of the forests and rangelands of California.

Scale:	Regional
Potential Data Sources:	CalFire FRAP
Data Availability:	Type II
Metric:	Threat-asset data from FRAP
Screening Status:	Advanced

Importance and Screening Results

California is recognized as one of the most fire-prone landscapes in the world. Research indicates trends of increased fire severity, increases in human infrastructure at risk, and climate change increasing hazards and risk associated with vegetation fires. However, the innate complexities of varying ecosystems and landscapes throughout California make it difficult for statewide and even regional generalizations to capture viable data for water supply vulnerability to wildland fires in California. This indicator is considered Advanced because its future development is directly dependent on the status and advancement of the FRAP indicator assessment.

Representative of Outcome:	Medium
Data Viability:	High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

Recommendations

Future work with the CalFire FRAP team could help direct data collection towards analyzing local threatened water supply systems. Current data on threats to water quality focus on prioritizing watersheds with high storage, high post-fire erosion potential, along with other indications of risk of post-fire water quality impacts.

In addition, determining the potential link of this indicator to the economic vitality indicators may help in developing a future methodology for its analysis.

References

California Department of Forestry and Fire Protection. 2010. Fire and Resource Assessment Program (FRAP): 2010 Assessment. Viewed online at:
http://frap.fire.ca.gov/data/assessment2010/pdfs/california_forest_assessment_nov22.pdf

Public Health and Safety

Intended Outcome: A reliable water supply for domestic needs, sanitation, and fire suppression.

PHS: Percent of Urban Fire Water Systems that Pass 5-year Mandated Inspections

This indicator would assess the percent of urban fire water systems that pass 5-year mandated inspections. These inspections assess the ability of water supply systems to provide fire suppression during emergency situations.

The Office of the State Fire Marshal regulates and enforces the State-mandated inspections, supporting CalFire. The mission of the State Fire Marshal is to protect life and property through the development and application of fire prevention engineering, education and enforcement.

Scale:	Regional
Potential Data Sources:	CalFire; Office of the State Fire Marshal; local municipalities and agencies
Data Availability:	Type III or IV
Metric:	Percent of Urban Fire Water Systems
Screening Status:	Advanced

Importance and Screening Results

The percent of local municipalities and agencies passing the mandated inspections for urban fire water systems would provide an indication on the need for additional water supply to protect a community from fire. However, this indicator is considered Advanced and should be viewed as a placeholder for a future indicator that would potentially better address urban fire protection. Currently, while the State Fire Marshall provides regulation and enforcement of the inspection mandate, no centralized database exists. Data may only be available at a local level through multiple entities. In addition, the inspection considers a variety of factors, including a lack of maintenance on fire prevention devices, and not only the availability of sufficient water.

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium-High
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

Recommendations

Future development of an indicator for urban fire protection is required. This indicator may focus on areas at risk of wildland fires rather than the state as a whole. Communities at risk from wildfire are provided through FRAP as Wildland Urban Interface spatial data. The ability to urban areas to withstand wildland fires plays an important role in protection public health and safety. Currently, the lack of available data prevents this indicator from being used to represent its intended outcome.

References

California Department of Forestry and Fire Protection. 2010. Fire and Resource Assessment Program (FRAP): 2010 Assessment. Viewed online at:
http://frap.fire.ca.gov/data/assessment2010/pdfs/california_forest_assessment_nov22.pdf

California Department of Forestry and Fire Protection. "FRAP Projects." California Department of Forestry and Fire Protection. Viewed online at: <http://frap.fire.ca.gov/projects/wui/index>. Last accessed: December 14, 2017.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

EV: California Integrated Assessment of Watershed Health

This indicator would identify healthy watersheds and characterize relative watershed health across the state to guide future protection initiatives. This indicator would draw from previous work by the U.S. EPA to develop composite indices as part of the U.S. EPA's California Integrated Assessment of Watershed Health.

For the purpose of this indicator, a healthy watershed is defined as having the structure and function in place to support healthy aquatic ecosystems. The target outcome for this indicator could include a healthy watershed condition, stream health, and minimal vulnerability to future degradation.

Scale:	Statewide
Potential Data Sources:	U.S. EPA
Data Availability:	Type II
Metric:	Composite Indicator
Screening Status:	Advanced

Importance and Screening Results

Healthy waters are a vital part of California's identity and economy. The state's high-quality streams, lakes, and wetlands provide a variety of benefits including supporting key ecological functions. Continued effort to protect existing high-quality waters throughout California can support the effectiveness of current efforts to restore impaired waters and prevent costly restoration in the future.

During the screening process, this indicator was determined to be an Advanced indicator. Although previously developed by the U.S. EPA, additional work and data collection would need accomplished to apply the indicator at a more refined scale throughout the state, potentially down to a watershed scale.

Future assessment would involve a systems approach that views watersheds and their aquatic ecosystems as dynamic and interconnected systems in the landscape connected by surface and ground water and natural vegetative corridors. Watershed health would be quantified across the state at the subwatershed scale from existing statewide geospatial datasets and from predictive models derived from field monitoring data collected as part of existing statewide assessment programs. This information would be further synthesized into indices that describe watershed condition, stream health, and vulnerability to future degradation.

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	High

Recommendations

This indicator is Advanced level, so framework and guidelines will continue to develop, potentially in parallel with the future development of U.S. EPA's California Integrated Assessment of Watershed Health. There are three main goals established by the California Integrated Assessment:

1. Integrate multi-disciplinary data to both identify healthy watersheds and characterize the relative health of watersheds across the state
2. Make watershed health data and information readily available to a variety of State, Federal, and local programs for watershed protection planning
3. Encourage inter-agency partnerships and collaboration to build upon previous efforts to assess watershed health and protect healthy watersheds

As part of the last two goals, additional collaboration with the U.S. EPA is recommended to further develop this indicator in the future. For example, the current report recommends placing the data layers used in the initial analysis into publicly available GIS files.

References

U.S. Environmental Protection Agency. 2013. California Integrated Assessment of Watershed Health. Prepared by: The Cadmus Group, Inc. Viewed online at:
https://www.epa.gov/sites/production/files/2015-11/documents/ca_hw_report_111213_0.pdf

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

EV: Deviation from Unimpaired Flows

This indicator would provide an assessment of what instream flows would be without factors that impair natural flows, such as reservoir regulation or hydrologic conditions. Flow standards and objectives help protect habitat and migratory signals for native fish species. This indicator may be more relevant in regions or watersheds that contain water bodies heavily regulated by reservoir operations, such as the San Joaquin region.

Scale:	Regional
Potential Data Sources:	State Water Board; DWR; USGS
Data Availability:	Type II
Metric:	Percentage of unimpaired flows
Screening Status:	Advanced

Importance and Screening Results

Currently, many of California's streams do not have adequate flows or seasonal variability of flows to support and protect fisheries and other ecological processes. Decreasing deviation from unimpaired flows through changes in reservoir regulation could help partially restore the natural functions of certain streams and rivers in California.

Currently, most reservoirs do not provide environmental flows. However, with new and updated flow standards and objectives for the San Joaquin River and southern Delta set by the State Water Board, the State continues to develop methods to improve environmental conditions even on impaired streams. Monitoring the deviation from expected unimpaired flows could show progress in meeting standards and objectives in applicable watersheds.

The viability of current data is unknown. This indicator may be highly variable and dependent on hydrologic condition. Therefore, this indicator was determined to be an Advanced indicator during the screening process.

Representative of Outcome:	Medium
Data Viability:	High
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

Recommendations

This indicator is Advanced level and will not be included as a sustainability indicator for the 2018 CWP Update. In the future, the methodology for assessing this indicator could be developed by comparing actual to models of unimpaired flows during periods particularly important to ecosystem functions. This indicator may only apply to certain watersheds in the state.

References

State Water Resources Control Board. “Development of Flow Objectives (Phase 4 of Bay-Delta Effort).”
State Water Resources Control Board. Viewed online at:
https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/flow_objectives/index.shtml. Last accessed: December 14, 2017.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

Number of Fish Rescues to Fish Kills and Fisheries Closed to Recreational and Commercial Activity

This indicator assesses the number of fish rescues and fisheries closed to recreational and commercial activity. Fish rescues and closures may occur when stream or water body conditions, such as inadequate flow or temperature, are unable to support fish populations. When large releases are made from dams, fish may require rescue to avoid stranding in side-channel habitat. For example, the high flows from Oroville Dam's broken spillway (2017) were rapidly decreased and fish rescues were required to prevent stranding of native fish species, such as Chinook salmon. CDFW oversees all fisheries closures and fish rescues and continues to work with DWR, Reclamation, and other dam operators to regulate release patterns and minimize the risk of stranding.

However, CDFW does not currently store historical data on fish rescues, kills, and fisheries closed to recreational and commercial activity. Therefore, although this indicator was considered Basic during the initial screening process, it has been moved to an Advanced indicator

The target outcome of this indicator is pending, but would be based on the data collected to evaluate the indicator. A likely target outcome to consider would be a high fish rescue to fish kill ratio and zero fisheries closed to recreational and commercial activity.

Scale:	Regional
Data Sources:	CDFW
Data Availability:	Type III
Metric:	Ratio of fish rescues to fish kills and fisheries closures
Screening Status:	Watershed

Importance and Screening Considerations

Fish species in California waterways have generally declined over time in response to changing habitat and flows. Fish are vital to maintaining the health of California waterways because they store a large proportion of ecosystem nutrients in their tissues, transport nutrients farther than other aquatic animals, and excrete nutrients that are readily available to primary producers. Ecosystems that depend on fish may be negatively impacted when large populations of fish are killed from stranding or other poor water quality issues, such as inadequate water temperatures.

This indicator was considered Watershed level, but is currently classified as an Advanced indicator based on the data that was found during further indicator development. This indicator may not be as relevant in areas throughout Southern California, but it could be a good indicator of ecological functions in coastal watersheds, the Delta, and portions of Northern California and the Central Valley. However, this indicator scored relatively low in the data viability, potential longevity, and supportive of decision making categories. Multiple agencies may hold information on this indicator, but no comprehensive, easily accessible database current exists that records historical fish rescues or fishery closures. In addition, this

indicator may not present enough information to be supportive of decision making or to provide a statewide assessment of functioning ecosystems.

Representative of Outcome:	Low-Medium
Data Viability:	Low
Cost:	High
Potential Longevity:	Low-Medium
Supportive of Decision Making:	Low-Medium

Initial Data and Results

Due to lack of a centralized database or historical data on fish rescues and fishery closures, there are no data or results to evaluate the indicator at this time. Further refinements to this indicator and a potential methodology are presented below.

Recommendations

This indicator is considered an Advanced level indicator. Once data is better developed, further work should be considered to determine the fish rescue to fish kill ratio and occurrences of fisheries closed to recreational and commercial activity.

In April 2016, the CDFW adopted regulations which grant CDFW authority to temporarily close fisheries experiencing degraded environmental conditions that may affect fish populations or their habitat within waters of the state. CDFW has developed a set of triggers to guide fishing closure and reopening decisions that are based on the most current monitoring information available. At present, only current inland fishery closures are posted on the CDFW site. In the future, a historical database should be developed for inland fishery closures as the adopted regulations continue to be enforced. For coastal and commercial fisheries, there are no available data for fish rescues or closures.

For future CWP updates, a geocoded map with watersheds color coded by the ratio of fish rescues to fish kills per watershed as the base that highlights the locations of fishery closures over the last five years, would be an appropriate way to visually represent this indicator. To obtain data, the CDFW would need to track their historical fish closures and track the number of fish rescues and kills caused by drought, inadequate reservoir operations, or other adverse conditions.

References

California Department of Fish and Wildlife. Fish and Games Commission. Viewed online at: <http://www.fgc.ca.gov/>. Last accessed: February 12, 2018.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

Forest Health

This indicator would combine multiple sets of data to assess the acreage of healthy forests in California. Healthy forests would be managed to improve heterogeneity in tree size and species, limit fuel loads and conditions that cause unmanageable wildfires, preserve snowpack, and increase runoff into watersheds.

The target outcome of this indicator is pending, but would be based on the determination of what factors are most indicative of a healthy managed forest that results in these stated outcomes.

Scale:	Regional
Data Sources:	Sierra Nevada Conservancy,
Data Availability:	Type IV
Metric:	To be determined.
Screening Status:	Advanced

Importance and Screening Considerations

Historically, many forests in California are adapted to frequent, low intensity fires. Current forest conditions, especially in low and middle elevation forests, are the result of fire suppression programs in the past century. These forests adapted to frequent, low intensity fires. In dry forest types, this legacy of fire suppression has resulted in dense, homogenous forests. These forests have high water demands and fuel loads. Catastrophic fires result when these fuel loads burn.

Efforts led by the Sierra Nevada Conservancy are working to develop an overall forest health indicator and determine what data must be developed to apply it on a large scale throughout the Sierra Nevada. These efforts could potentially be expanded to other Californian forests. However, data sets related to forest health are currently limited to individual studies. Therefore, this indicator is considered an Advanced indicator, despite its ability to support decision making. This indicator may not be relevant in desert, rural, or agricultural areas of the state. The indicator may be adapted for and potentially be applied to chaparral areas of the state, which have also faced fire suppression in the past century.

Representative of Outcome:	High
Data Viability:	Low
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	High

Initial Data and Results

No consensus is available on the best indicator of a healthy forest. Therefore, no data or results are presented for this indicator at this time.

Recommendations

This indicator is considered an Advanced level indicator. A collection of agencies are developing indicators for forest health. Once additional consensus is reached and centralized data is available, further work could allow a forest health indicator to be applied statewide.

References

Boisramé, Gabrielle; Thompson, Sally; Collins, Brandon; Stephens, Scott. 2017. Managed wildfire effects on forest resilience and water in the Sierra Nevada. *Ecosystems*. 20(4): 717-732.
<https://doi.org/10.1007/s10021-016-0048-1>.

Sierra Nevada Adaptive Management Project. 2015. Appendix E: Water Team Final Report. Viewed online at:
http://snamp.cnr.berkeley.edu/static/documents/2016/01/25/E_Water_quantity_and_quality_chapter_Final_Dec_14_2015compressed.pdf. Last accessed: May 4, 2018.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California.

Number of Fish Consumption Advisories

This indicator assesses the number of fish consumption advisories statewide. This indicator is similar to *PHS 6: Potential for Consumption of Mercury-Contaminated Fish*, but this indicator evaluates consumption advisories rather than the potential for consumption.

Fish consumption advisories are prompted by the OEHHA. The OEHHA provides recommendation on how often you can safely eat certain types of fish from water bodies in California. Most advisories are issued because of mercury in fish. The target outcome for this indicator would be zero fish advisories are required in the state. However, a statewide advisory is currently enacted across all state water bodies. Therefore, although this indicator was considered Basic during the initial screening process, it has been moved to an Advanced indicator. Unless site-specific advisories have been established for all water bodies, analyzing this indicator will not produce useful information to analyze the progress of policy decisions. Currently, this indicator showing increases in fish advisories would indicate additional data was analyzed by OEHHA, rather than an increase in polluted water bodies.

Scale:	Statewide
Data Sources:	OEHHA
Data Availability:	Type I
Metric:	Number of Fish Advisories
Screening Status:	Advanced

Importance and Screening Considerations

Fishing is a popular activity enjoyed by many Californians throughout the state, however fish may contain pollutants that can harm human health if consumed too often at high concentrations. The most common chemicals found in California fish are mercury and polychlorinated biphenyls, and sometimes dichloro-diphenyl-trichloroethane and dieldrin, which are common constituents of concern in California water bodies. Fish consumption advisories issued by OEHHA help lower the risk associated with consuming contaminated fish by providing the public with information on safe eating guidelines on both statewide and site-specific levels.

This indicator was considered Basic level, but is currently classified as an Advanced indicator based on the data that was found during further indicator development. California's OEHHA already keeps information on fish advisories throughout the state. This indicator is easy to understand by various decision makers and data are easy to access statewide. This indicator reflects ecosystem vitality, but can also represent public health and safety concerns.

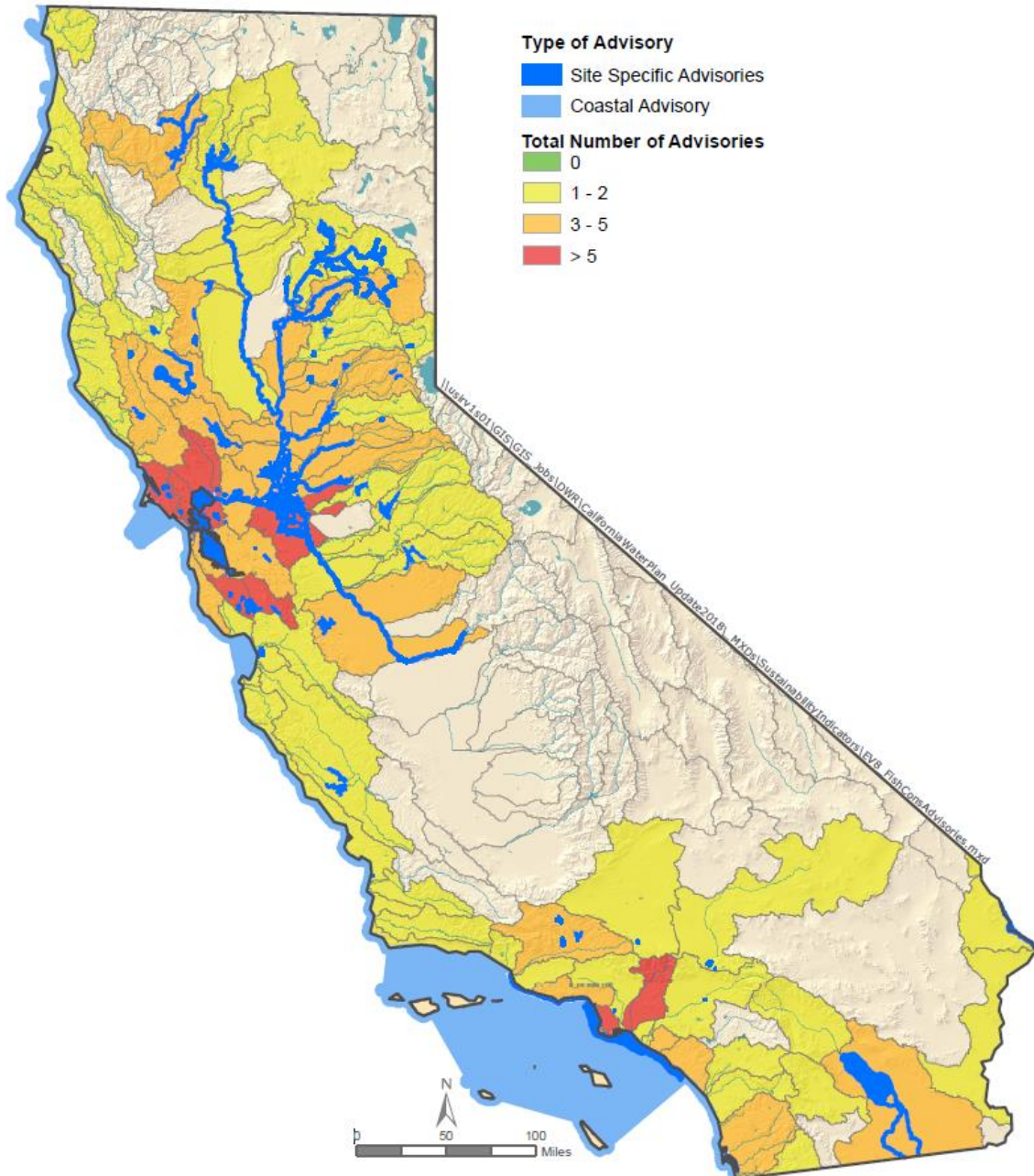
However, since OEHHA considers all water bodies under a statewide advisory, the potential trends in the data will not produce useful information on the outcome. Until a statewide advisory is broken down into site specific advisories, this indicator will not be supportive of decision making.

Representative of Outcome:	High
Data Viability:	Medium-High
Cost:	Low-Medium
Potential Longevity:	Medium
Supportive of Decision Making:	High

Recommendations

This indicator is considered an Advanced level indicator. Once data is better developed, further work should be considered to determine the rate in which fish advisories are being issued and redacted. OEHHA should continue to provide advisories for water bodies as further analysis continues at individual sites. In addition, OEHHA should develop a collective shapefile download for all advisories, rather than individual downloads for recent advisories, to allow for an easier analysis of all fish consumption advisories throughout the state.

Although this indicator has been classified as an Advanced level indicator, initial data on the current set of site-specific advisory locations and their enacted dates were downloaded from OEHHA's website. The OEHHA provides GIS files for certain advisories. For advisories where no GIS file was provided for download, additional sources were used to supplement OEHHA's data. The total number of advisories per watershed was calculated. Both the location of the individual advisories and the number per watershed are displayed in Figure 4-36. Although these advisories vary in severity, areas with higher populations have watersheds with more advisories. Ninety-four site specific advisories have been added by OEHHA since 1987.



Source: "Fish Advisories." Office of Environmental Health Hazard Assessment. November 14, 2017.

Figure 4-36. Number of Fish Consumption Advisories

References

Office of Environmental Health Hazard Assessment. "Fish Advisories." Office of Environmental Health Hazard Assessment. Viewed online at: <https://oehha.ca.gov/fish/advisories>. Last accessed: November 14, 2017.

State Water Resources Control Board. "Statewide Mercury Provisions." State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/water_issues/programs/mercury/. Last accessed: January 23, 2018.

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply.

HE: Real Cost of Water to End User

This indicator would help assess the real cost of water to end users. Factors included in the real cost of water to end users include treatment costs, conveyance costs, and costs for infrastructure development, improvement, and rehabilitation. The target outcome for this indicator is that the real cost of water to end users represents a fair and economical cost, similar to the cost to actually produce the water.

Scale:	Statewide
Potential Data Sources:	DWR; SWP Billings
Data Availability:	Type III
Metric:	Real Cost of Water (\$)
Screening Status:	Advanced

Importance and Screening Results

While the economic value of water is difficult to determine, regardless of its final purpose, the real cost of water to its end users would be indicative of changes in water's affordability in California. Much of the state's water supply, wastewater, and flood control infrastructure is aging. Rehabilitation and maintenance often includes improvements to meet increasingly high standards for water quality and infrastructure safety. Climate change and water shortages can also drive changes in the real cost of water.

The screening process determined this indicator is an Advanced indicator. No current methodology exists to evaluate the real cost of water to end users. Different regions, systems, and stakeholders consider different factors in calculating the real cost of water. Therefore, without an established framework, this indicator cannot yet be fully developed.

Representative of Outcome:	High
Data Viability:	Medium
Cost:	High
Potential Longevity:	Medium-High
Supportive of Decision Making:	Medium-High

Recommendations

This indicator is Advanced level, so framework and guidelines will continue to develop once more reliable data or methodologies exist. The methodology for this indicator would be developed to consider the total costs involved to secure, transport, treat, and deliver water supplies to end users. This indicator may need to be evaluated by region to note trends in the cost of water regionally and statewide.

References

None.

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply.

HE: Watershed Drought Response Capacity Index

This indicator would develop a watershed drought response capacity index to assess and rank watersheds based on their vulnerability to a multi-year drought. This new index would consider the following aspects of each watershed:

- Population reliant on water supply sources
- Water supply assets (regional and imported)
- Operational Flexibility
- Carryover storage capacity in surface and groundwater supplies

Each watershed faces unique drought conditions and has varying capacity to respond to multi-year droughts. A composite index would support statewide comparison of watersheds.

Scale:	Regional
Potential Data Sources:	Local and State entities
Data Availability:	Type IV
Metric:	Composite index
Screening Status:	Advanced

Importance and Screening Results

The 2012-2016 drought conditions in California underscored both the importance of water use efficiency and the need to achieve greater resilience in the face of varying hydrologic conditions. The period from 2012 through 2014 are on record as California's driest three consecutive years with respect to statewide precipitation. During this multiyear drought, many communities were unable to provide stable, safe water supplies to their residents for household uses. Assessing the vulnerability of watersheds to multi-year droughts would help the state assess what areas require additional development of resilience against drought conditions.

Since no index has been developed and data availability is unknown, the screening process placed this indicator on an Advanced level. However, an index considering population, water supply, operational flexibility, and carryover storage capacity would be representative of the intended outcome and highly supportive of decision making.

Representative of Outcome:	Medium-High
Data Viability:	Medium
Cost:	High
Potential Longevity:	High
Supportive of Decision Making:	High

Recommendations

Methodology for this indicator should be developed as data becomes more widely available. The methodology should focus on developing a widely applicable index value to compare the vulnerability of individual watersheds' and regions' water supply to multi-year droughts.

References

State Water Resources Control Board. "Drought Preparedness, Water Conservation and Water Supply Emergency Response." State Water Resources Control Board. Viewed online at: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/DroughtPreparedness.shtml. Last accessed: December 14, 2017.

Opportunities for Enriching Experiences

Intended Outcome: Continued and enhanced recreational opportunities in waterways, reservoirs, or natural and open spaces.

OEE: Average Distance to Water-related Recreational Resources

This indicator would assess the average distance to water-related recreational resources to help determine the accessibility to water-related resources throughout California. Data for this indicator would be developed using maps or location assessments provide by California Department of Parks and Recreation coupled with the average distance from the center of mass of populations to water-related parks.

Scale:	Statewide
Potential Data Sources:	California Department of Parks and Recreation
Data Availability:	Type III
Metric:	Distance (miles) from population centers
Screening Status:	Advanced

Importance and Screening Results

Although there are ample water-related State lands and parks throughout California, inaccessibility due to the amount of travel required to access these State lands and parks may prevent all Californians from enjoying these spaces.

This indicator was considered Advanced during the screening process, because while it would be fairly representative of its outcome and supportive of decision making, significant data and methodology development would be required.

Representative of Outcome:	Medium
Data Viability:	Low-Medium
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

Recommendations

This indicator is Advanced level and should be considered a future indicator. Methodology for this indicator may be similar to how city and county recreational assessments evaluate the need for investments in community recreational facilities. This indicator would assess several factors such as the effect of distance on visitor use days or overall accessibility of the water-related resources.

References

None.

6 Archived Sustainability Indicators

This section provides a brief description of each sustainability indicator that was archived during the planning process. Table 6-1 lists the 40 indicators that were archived during the planning process for each intended outcome. Indicators were archived for several reasons, with the most common reasons including lack of access to viable data, overlap with other indicators, or the indicator was not representative of the intended outcome.

Each description provides insight on the screening process and why each indicator was chosen to be archived instead of included as an indicator to use in the 2018 pilot studies or future California Water Plan Updates.

Table 6-1. Comprehensive List of Archived Indicators that will not be Considered as Sustainability Indicators for Future California Water Plans

Ref No.	Public Health and Safety
A reliable water supply for domestic needs, sanitation, and fire suppression.	
1	Number of Dry Water Supply Wells
2	Number of Water Bottles Distributed
3	Number of Private Water Supply Wells
4	Number of People and Percent of Population Relying on Contaminated Groundwater for Domestic Water Supply
5	Number of Native American Tribal Communities without Access to Reliable Water Supplies
Reduce number of people exposed to waterborne health threats such as contaminants or infectious agents.	
6	Mercury Levels in Fish Consumed by Humans
7	Number of Small Systems on Fractured Groundwater Sources
Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure)	
8	Number of Days per Year that CVP and SWP Facilities Experience Unplanned Service Outages
9	Population in Floodplains with Equal to or Greater than 0.2 Percent Chance of Flooding in any Given Year
Ecosystem Vitality	
Maintained and increased ecosystem and native species distributions in California while sustaining and enhancing species abundance and richness	
10	Water Temperature, Chemistry, and Pollutant/Nutrient Concentrations and Dynamics
11	Water Quantity and Availability for Environmental Purposes

Table 6-1. Comprehensive List of Archived Indicators that will not be Considered as Sustainability Indicators for Future California Water Plans (contd.)

Ref No.	Public Health and Safety
Healthy Economy	
Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply.	
12	Changed is Water Use of Water Bodies
13	Percent of Communities Showing a Neutral (or excess) Water Balance in their Approved UWMP/AWMPs
14	Drought Carryover Storage in Reservoirs
15	Groundwater Levels and Quality
16	Groundwater Wells that do not Meet Drinking Water Quality Standards
17	Water Available for Groundwater Recharge
18	Value of Agriculture Production per Acre Foot delivered
19	Number of Acres Under Production Experiencing Water Stress
Consideration of economic risks and rewards of floodplains, rivers, and coastal areas.	
20	Number of Sea-Level Rise Preparedness Assessments Completed per Assembly Bill 691
21	Economic Value of Lands Held in Conservation and Open Space
22	Improvement to Flood Safety
More benefits from economic activities, including from reduced costs to provide a given level of service (including transaction and permitting costs).	
23	Public and Legislative Support for Water Measures
24	Comparison of Water Rates and Household Income to the National Average Rates
25	Compare Gross Domestic Product to Gallons per Capita per Day
26	Number of Water Facilities that are Beyond Design Life
27	Book Value of Assets in Water Infrastructure and Replacement Costs
28	FERC Licenses and Number of Renewals (50 Year Licenses)
29	Land Use Changes - Agricultural/Urban/Industrial/Open Space
30	Water Transfers (water moving from higher to valued users)
31	Social Safety (water used for industry instead of agriculture)
32	[Gross Domestic Product]/[Consumptive Use]
33	Consumer Price Index vs. Aggregated Cost of Service (all agencies)
34	Change in End Use (agriculture, urban, industrial, open space) Mapped
35	Five Year Rolling Average of Hydropower Generation vs. Total Generated
Reduced likelihood or occurrence of significant social disruption following a disaster.	
36	Number (cumulative) of Water-Related Emergency Declarations Over Time
37	Lost Business Income from Water-Related Emergency Declarations

Table 6-1. Comprehensive List of Archived Indicators that will not be Considered as Sustainability Indicators for Future California Water Plans (contd.)

Ref No.	Public Health and Safety
Opportunities for Enriching Experiences	
Preserved or enhanced culturally or historically significant sites and communities, including continued and enhanced access to water and land used for sacred ceremonies or cultural practices.	
38	Number of Qualified Historical Buildings or Places at Risk of Losing Reliable Water Supplies
Preserved and increased natural areas with aesthetic or intrinsic value (including view shed).	
39	Statewide Open Space
40	Conserved Lands Adjacent to California Waterways (acreage)
41	Land Conservation Williamson Act Enrollment (acreage)
Continued and enhanced recreational opportunities in waterways, reservoirs, or natural and open spaces.	
42	Number of Communities Without Access to Water-Related State Lands, Parks, or Resources
43	Change in Water Bodies that Allow Contact Recreation
44	Change in Miles of Boatable (Recreational) Waterways

Key:

AWMP = Agricultural Water Management Plan

FERC = Federal Energy Regulatory Commission

UWMP = Urban Water Management Plan

Public Health and Safety

Intended Outcome: A reliable water supply for domestic needs, sanitation, and fire suppression

PHS: Number of Dry Water Supply Wells

This indicator would assess the number of water supply wells that are dry.

Screening Process

Representative of Outcome:	Low
Data Viability:	Low
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- Good indicator in some watersheds that have a strong dependence on groundwater, but not reflective on a statewide scale.
- Data are collected by dispersed entities.
- Data are less accessible for rural areas.

PHS: Number of Water Bottles Distributed

This indicator would assess the number of water bottles distributed in communities or areas where access to reliable water supply is challenging. Lack of access to adequate water supplies to meet basic domestic needs can be caused by a variety of underlying conditions, including drought, poor water quality, affordability, insufficient infrastructure, and others. In some cases, bottled or tanked water must be transported into these communities to meet basic needs.

Screening Process

Representative of Outcome:	Low
Data Viability:	Medium
Cost:	Low
Potential Longevity:	Low
Supportive of Decision Making:	High

This indicator was archived for the following reasons:

- This indicator would not show trends because it is event driven.
- Water bottles are typically distributed during certain timeframes when public health and safety is facing a direct threat, such as during drought or wildfire events.

- There are limited data available and when there are data, it would require significant coordination between multiple entities in different sectors (churches verses local municipalities).

PHS: Number of Private Water Supply Wells

This indicator would assess the number of private water supply wells in California. Up to 2 million California residents are served either by domestic private wells or by water systems serving fewer than 15 service connections. Private domestic well owners are responsible for maintaining their well and are encouraged to test their well water quality, but there are no current State regulations on private wells.

Screening Process

Representative of Outcome:	Low
Data Viability:	Medium
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- The number of private water supply wells is neither good nor bad for the intended outcome.
- It is hard to determine the amount of water that is actually supplied by private wells due to lack of regulations.
- Some wells that would be considered in the evaluation of this indicator may not be active or may supply very little water.
- Data are not available for the water quality or quantity from private water supply wells.

PHS: Number of People and Percent of Population Relying on Contaminated Groundwater for Domestic Water Supply

This indicator would assess the percent of the population reliant on contaminated groundwater for domestic water supply purposes, targeting zero percentage of the population relying on contaminated groundwater. For this indicator, a population that relies on contaminated groundwater was initially defined as a public water system that draws water from a contaminated groundwater source prior to any treatment. Most contamination is removed during the treatment processes. However, private domestic wells, without the same regulations for monitoring and treatment, remain at risk.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium-High
Potential Longevity:	Medium
Supportive of Decision Making:	High

This indicator was archived for the following reasons:

- Although considered as a Watershed indicator after the initial screening process, information on groundwater contamination was condensed into *HE 7, Contaminated Groundwater Wells*.
- The initial methodology for evaluating this indicator was based on the State Water Board's report, *Communities that Rely on a Contaminated Groundwater Source for Drinking Water*. The report only analyzed data from groundwater sampled directly from a well or groundwater sampled at a point between the well and a treatment system. This methodology was considered less applicable than considering all contaminated groundwater wells in the State.

PHS: Number of Native American Tribal Communities without Access to Reliable Water Supplies

This indicator would assess the number of tribes and tribal communities without access to reliable and safe water supplies. A positive trend for this indicator is a decrease in the number of tribal communities without access to reliable water supply. The target outcome for this indicator would be that all Native American Tribal Communities have access to reliable water supplies.

The 1988 amendments to the IHCI require the IHS to maintain inventories of sanitation deficiencies for new and existing American Indian and Alaskan Native homes and communities. Data from IHS have previously been used to determine the number of homes with certain IHS Deficiency Levels in Update 2013.

Screening Process

Representative of Outcome:	High
Data Viability:	Medium - High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	High

This indicator was archived for the following reasons:

- Although considered as a Basic indicator after the initial screening process, information specific to Native American Tribal Communities was combined into *PHS 1, Population and Percentage of Population with Reliable Domestic Water Supplies*, and *PHS 2, Population and Percentage of Population without Access to Reliable Sanitation*.
- Originally, this indicator was found to be highly representative of its target outcome, as having reliable access to safe drinking water is a direct indicator of public health and safety. Extensive data exist in the IHS STARS database, and these data are readily compiled for analysis of this indicator. This indicator, supportive of decision making, shows California how well the water supply is managed for tribal communities and whether or not changes to management practices and/or policies need to be made.

Public Health and Safety

Intended Outcome: Reduce number of people exposed to waterborne health threats such as contaminants or infectious agents

PHS: Mercury Levels in Fish Consumed by Humans

This indicator would assess the levels of mercury in fish consumed by humans in California. Mercury is considered a toxic substance in the human body and is also included as a constituent of concern for many water bodies on the 303(d) impaired water bodies list. The Clean Water Act Section 303(d) List is a list of impaired and threatened waters (streams, river segments, lakes) that have identified the pollutants causing the impairment.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Low-Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- Another indicator has been identified (*PHS 6, Potential for Consumption of Mercury-Contaminated Fish*) and further assessed that is more representative of the intended outcome. This indicator was eliminated so the evaluation of mercury concentrations was already represented.

PHS: Number of Small Systems on Fractured Rock Groundwater Sources

This indicator would assess the number of water systems on fractured rock groundwater sources. Groundwater contamination by microbiological contaminants may be a concern when water wells are improperly sealed, or when there is release of sewage or seepage directly into groundwater.

Screening Process

Representative of Outcome:	Low
Data Viability:	Low-Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Low

This indicator was archived for the following reasons:

- This indicator would only apply to communities who rely on groundwater sources.

- This indicator may only be indicative in rural communities.
- The assessment of this indicator would only provide the potential for the impact on the groundwater sources.

Public Health and Safety

Intended Outcome: Reduce number of people exposed to waterborne health threats such as contaminants or infectious agents

No indicators considered during the planning process were archived for this intended outcome.

Public Health and Safety

Intended Outcome: Reduced loss of life, injuries and health risks caused from extreme hydrologic conditions, catastrophic events and/or system failures (including infrastructure)

PHS: Number of Days per Year that CVP and SWP Facilities Experience Unplanned Service Outages

This indicator would assess the number of days per year that CVP and SWP facilities experience unplanned service outages. CVP and SWP facilities support water supplies for a variety of purposes. The CVP and SWP play major roles in California's water supply and water storage system. Many regions in California rely heavily on water from the CVP and SWP systems. The CVP extends from the Trinity Dam in the Cascade Range south along the San Luis Canal and Friant-Kern Canal, including several major dams along the western Sierra Nevada. Major features of the SWP include Oroville Dam, San Luis Reservoir (a shared facility with the CVP), and the California Aqueduct. Both these projects serve many purposes including providing water storage and delivery for domestic, agricultural, and industrial needs; providing flood protection; generating hydropower; and supporting recreational opportunities.

Screening Consideration

This indicator is considered a Basic level indicator. The SWP collects data on outages through its Operations Control Office. The Annual Report of Operations for the SWP provides monthly and end-of-year status of its water and power operations. The report also provides data on SWP service outages. A similar report does not exist for CVP facilities.

Representative of Outcome:	Medium
Data Viability:	High
Cost:	Medium-High
Potential Longevity:	High
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- Although initial data was collected, no information was available to link unplanned service outage data to decreases in deliveries. Redundant systems in place often prevent health and safety impacts during outages.
- Initial data were provided for the SWP through personal communications with DWR's Outage Management Branch. These data covered "Noteworthy Forced Outages" throughout the SWP system during the 2017 calendar year. In total, 125 forced outages lasting over 24 hours occurred in 2017 for a total of 34,840 combined hours of lost operations in pumps and generators at various facilities. Thirty-three of these lasted over three days.
- No data is publicly available for the CVP.

Recommendations

This indicator is considered a Basic level indicator, so the guidelines and framework for measuring the indicator will continue to develop.

Further work should be done to determine the impact of unplanned service outages on deliveries to accurately represent this indicator's intended outcome. In addition, data collection on the CVP through coordination with Reclamation is necessary to fully characterize both major water delivery systems.

References

California Department of Water Resources. "State Water Project Annual Report of Operations." Last accessed: February 6, 2018.

U.S. Department of the Interior, Bureau of Reclamation. "Central Valley Operations Office." U.S. Department of the Interior, Bureau of Reclamation. Viewed online at: <https://www.usbr.gov/mp/cvo/index.html>. Last accessed: February 15, 2018.

PHS: Population in Floodplains with Equal to or Greater than 0.2 Percent Chance of Flooding in any Given Year

This indicator would assess the population that lives in floodplains with equal to or greater than a 0.2 percent chance of flooding in any given year throughout the state. During initial indicator development, some feedback related to reflecting more frequent flooding events (i.e., 2 percent change of flooding in any given year, or 50-year floodplains). As the state is experiencing increasingly intense and more frequent extreme events (droughts and floods), and no State or Federal agencies currently develop or maintain 50-year floodplain maps, this indicator was formulated for 500-year floodplains.

Screening Considerations

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Low
Potential Longevity:	High
Supportive of Decision Making:	High

This indicator was archived for the following reasons:

- Due to the similarity in subject and methodology, this indicator was incorporated into *PHS 10, Population within Floodplains with Equal to or Greater than 1 Percent Change of Flooding in any Given Year*.

Ecosystem Vitality

Intended Outcome: Maintained and increased ecosystem and native species distributions in California while sustaining and enhancing species abundance and richness.

EV: Water Temperature, Chemistry, and Pollutant/Nutrient Concentrations and Dynamics

This indicator would assess several criteria related to water quality including water temperature, chemistry, and pollutant/nutrient concentrations. Specifically, this indicator would assess water bodies on a case by case basis by utilizing the constituents listed on the Clean Water Act Section 303(d) List for each water body.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- Although measurable characteristics of systems are indicators of overall ecological health, the assessment of whether they're good or bad is dependent on specific biological processes.
- Ecosystems require different water temperatures and chemistry to thrive, which would make this indicator difficult to assess on a statewide scale.
- Other indicators have been identified as Basic in the Ecosystem Vitality Sustainability Outlook assessment that would capture overall watershed ecological health more effectively,

EV: Water Quantity and Availability for Environmental Purposes

This indicator assesses the amount of water available for environmental purposes. Water for environmental purposes would include water for refuge water supply, instream flow standards, water temperature and flow requirements, and timing of flows. Water availability and quantity are dependent on each other and on water rights, so this indicator would be a composite indicator of water quantity, timing, and quality. The CDFW helps set and enforce instream flow standards and ensure refuge water supplies are allocated throughout the state.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium-High
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- Water availability and quantity are dependent on each other and on water rights, so this indicator would be considered a composite indicator that would require evaluation of water quantity, timing, and quality.
- The data are highly dependent on regulatory requirements and water rights.
- There is no existing comprehensive data set to assess this indicator.

Ecosystem Vitality

Intended Outcome: Maintained and improved ecological functions and processes vital for sustaining ecosystems in California

No indicators considered during the planning process were archived for this intended outcome.

Ecosystem Vitality

Intended Outcome: Achieved designated beneficial uses for water bodies throughout the state.

No indicators considered during the planning process were archived for this intended outcome.

Healthy Economy

Intended Outcome: Reliable water supplies of suitable quality for a variety of productive uses, and productive water uses are based on a reliable supply.

HE: Changes in Water Use of Water Bodies

This indicator would assess the change in water use of water bodies throughout the state, which would be indicative of evolving water demands based on economic needs. Water, like any resource, will move to the highest value purpose. For example, a reservoir that was once considered for agricultural needs could be converted to a municipal water supply as a result of urban population growth nearby. Each purpose would define a different baseline for water use, which would have different impacts to California's economy. This assessment could also be indicative of demographics.

Screening Process

Representative of Outcome:	Low
Data Viability:	Medium
Cost:	Low
Potential Longevity:	Low
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- Although it would be indicative of the ability of California's water system to remain flexible based on economic or demographic needs, the accessibility of data may be difficult with respect to tracing the amount of water that is used for agricultural purposes.
- Difficulties would arise when trying to obtain data from all agricultural communities throughout the state, which would produce significant data gaps.

HE: Percent of Communities Showing a Neutral (or excess) Water Balance in their Approved Urban Water Management Plan and/or Agricultural Water Management Plan

This indicator would assess the number or percentage of communities that show a neutral or excess water balance in their approved UWMPs or their Agricultural Water Management Plans (AWMP). Based on the supply provided by urban water suppliers or agricultural water suppliers, DWR requires suppliers to develop and submit either a UWMP or AWMP that meets requirements identified in the California Water Code. For the purposes of this indicator, an excess water balance would show an excess in water supply.

Screening Process

Representative of Outcome:	Low
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Low
Supportive of Decision Making:	Low

This indicator was archived for the following reasons:

- Not all urban or agricultural water suppliers are required to submit UWMPs or AWMPs, so there would be significant data gaps statewide and regionally.
- Not all regions throughout the state have water budgets, such as areas that rely heavily on groundwater.

HE: Drought Carryover Storage in Reservoirs

This indicator would assess the drought carryover storage in reservoirs throughout California. Carryover storage is defined as the water stored as spills at the end of one year that is carried over to the next.

Screening Process

Representative of Outcome:	Medium
Data Viability:	High
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- Carryover storage is dependent on operational agreements and regulatory factors that may or may not be indicative of problems associated with water supply reliability.
- Carryover storage is highly dependent on hydrologic conditions, which would make the data hard to assess long term.
- An indicator that would be more focused on water availability during an emergency response would be more representative of the intended outcome.

HE: Groundwater Levels and Quality

This indicator would assess groundwater levels and quality throughout California's groundwater basins. SGMA requires locally managed groundwater sustainability agencies to implement sustainability plans requiring the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.

Screening Process

Representative of Outcome:	Low
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- Data viability is not an issue with groundwater levels and quality, but some of the data associated with this indicator would overlap with other indicators that would be more representative of the outcome.

HE: Water Available for Groundwater Recharge

Groundwater aquifers can act as underground reservoirs that can accommodate excess water and ease the pressure on our surface water reservoirs that can accommodate excess water during wet years. Groundwater recharge can either occur naturally or artificially.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Low-Medium
Cost:	Medium-High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- Currently, groundwater basins do not collect this type of data year to year.
- There are other indicators developed that achieve a similar evaluation and are more representative of the intended outcome.

HE: Value of Agriculture Production per Acre Foot Water Delivered

This indicator would assess the value of the agriculture production per acre foot of water delivered to agricultural crops. California's agriculture is a diverse and dynamic sector of the state's economy. This sector is also a significant consumer of California's water and energy.

Screening Process

Representative of Outcome:	Low
Data Viability:	Low
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- There are a variety of crops produced throughout California, so the evaluation would need to either evaluate all types of crops or pick several crops that would be representative of a range of values.
- This presents multiple challenges, such as determining which crops best represent the value of agricultural production.
- This indicator is more relevant in agricultural regions in California and may not be representative statewide.

HE: Number of Acres under Production Experiencing Water Stress

This indicator would assess the acreage of agricultural production that is experiencing stress from inadequate water supply reliability. California's water system is often stretched and particularly in more rural communities where a lot of agricultural production occurs.

Screening Process

Representative of Outcome:	Medium-High
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- It would be difficult to gather viable data to adequately represent this indicator.
- There are multiple reasons agricultural production may experience water stress. Some agricultural landowners may have invested water supply that was lost due to lack of water storage during a particularly wet season while others may not be able to afford the adequate water supply required for their particular agricultural crop due to increased water rates.
- The results of this indicator would not be representative of the outcome because the assessment is unable to differentiate the stresses on water supply.

Healthy Economy

Intended Outcome: Consideration of economic risks and rewards on floodplains, rivers, and coastal areas.

HE: Number of Sea-Level Rise Preparedness Assessments Completed per Assembly Bill 691

This indicator would assess the number of Sea-Level Rise Preparedness Assessments completed throughout the state per Assembly Bill 691. Assembly Bill 691 requires trustees of granted lands with average annual gross public trust revenues exceeding \$250,000 to submit a sea-level rise adaptation strategy assessment to the Commission by July 1, 2019.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	High
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- This indicator covers the same evaluation as *HE 9, Areas Covered by Local Coastal Program Vulnerability Assessments Updated for Sea Level Rise*.

HE: Economic Value of Lands Held in Conservation and Open Space

This indicator would assess the value of lands held in conservation and open space for ecosystem services to assess the overall economic value the conservation and open space lands provide the state.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Low-Medium
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- This indicator is covered through the evaluation of *OEE 2, Change in Natural Area*. However, *OEE 2* does not directly assess the economic value of the lands held in conservation and open space.
- This indicator was archived to eliminate repetitiveness.

HE: Improvement to Flood Safety

This indicator would assess the improvements to flood safety throughout the state including reduced flood insurance rates, home value changes, and the value of avoided recovery and clean-up costs.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Low-Medium
Cost:	Medium-High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- The data required to cover all aspects of flood safety would require extensive data compilation from multiple entities.
- The data, if available, would also be difficult to track down.
- Flood safety improvements are addressed in other indicators that are included in the indicator set (*PHS 9, Urban Population without State-Mandated Urban Level of Flood Protection; PHS 10, Population in Floodplains with Equal to or Greater than a 1 Percent Chance of Flooding in any Given Year; and HE 14, Value of Assets within Floodplains with Equal to or Greater than a 1 Percent Chance of Flooding in any Given Year*).

Healthy Economy

Intended Outcome: More benefits from economic activities, including from reduced costs to provide a given level of service (including transaction and permitting costs)

HE: Public and Legislative Support for Water Measures

This indicator would assess the degree of public and legislative support for California water measures. Developing more reliable funding for environmental management, flood protection, and statewide data collection could help support California's economic vitality.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Low-Medium
Cost:	Low
Potential Longevity:	Low-Medium
Supportive of Decision Making:	Low

This indicator was archived for the following reasons:

- There are no historical data sets to support the evaluation of this indicator and it would also be difficult to evaluate in the future.
- This indicator is not scientifically based. It's a measure of how supportive the public could be with moving projects forward, but would be biased with the existing economic situation.
- The outcome of the indicator wouldn't be definitive. It could be an indicator that the proponent of the water measure is a good communicator or it should indicate the water measure is good if everyone supports it.

HE: Comparison of Water Rates and Household Income to the National Average Rates

This indicator would assess the comparison between water rates and household incomes and further compare the state water rates to the national average rate. There are several different drivers associated with the cost of water, including energy costs and demand.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- There is broad variation associated with water rates in California, so it would be more useful to track local trends than compare rates against a state or national average.
- This indicator does not recognize that different regions face different water challenges that drive the cost of water.

HE: Compare Gross Domestic Product to Gallons per Capita per Day

This indicator would assess the relationship between the trend in the daily consumption of water per capita and the GDP. The GDP is one of the primary indicators used to gauge the health of a country's economy. It represents the total dollar value of all goods and services produced over a specific time period and reflects the size of the economy.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	High
Potential Longevity:	Low-Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- Water is not the only economic factor in economic productivity, so this indicator is not very representative of the intended outcome or societal value.
- This indicator may be useful in some regions whose economic activities rely on water supply, such as agricultural or industrial communities. However, this indicator would not be very representative on a statewide scale.

HE: Number of Water Facilities that are Beyond Design Life

This indicator would assess the number of water-related infrastructure facilities, such as water treatment plants, that are beyond design life. Much of California's water infrastructure is nearing the end of its useful life and approaching the age at which it needs to be replaced.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Low
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- Data viability is an issue for this indicator.
- While this is a good indicator of the level of investment that may be needed into the future to maintain water supply reliability, it does not tie directly to the intended economic outcome

HE: Book Value of Assets in Water Infrastructure and Replacement Costs

This indicator would assess the book value of water infrastructure assets and the replacement costs associated with water infrastructure. The book value is calculated by taking the cost of the asset minus the accumulated depreciation.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Low
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- The value of water infrastructure assets is not necessarily indicative of sustainable management.
- This indicator would be more useful in combination with other indicators or is captured by other indicators. For example, the cost of water is indicative of investments in facilities to provide sustainable water supply.

HE: FERC Licenses and Number of Renewals (50-year licenses)

This indicator would assess the number of Federal Energy Regulatory Commission (FERC) 50-year licenses currently issued in the state, including the number of renewals issued. FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil.

Screening Process

Representative of Outcome:	Low
Data Viability:	High
Cost:	High
Potential Longevity:	Low
Supportive of Decision Making:	Low

This indicator was archived for the following reasons:

- The number of licenses and renewals of power sources does not necessarily indicate a certainty of power generation over a license period.

- This indicator is not representative of the outcome and would not be supportive of decision making.

HE: Land use Changes – Agricultural/Urban/Industrial/Open Space

This indicator would assess land use changes, which would be correlated with a change in the end use of water. For example, if agricultural land is converted to urban land to support a new development due to a recent population boom, agricultural water demand would no longer be required. Instead, there would be a demand for urban water use.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Low

This indicator was archived for the following reason:

- There is no ideal land use distribution, so assessing a target outcome for this indicator would be difficult.

HE: Water Transfers (Water Moving to Higher Valued Uses)

This indicator would assess water transfers on the open market where water moves to a higher valued use. Water transfers involve a change in the place of water use, from the water's historic point of diversion and use, to a new location or water use. Water may be transferred on the market for a variety of purposes, including agricultural, municipal, environmental, and industrial uses. There are different types of water transfers and exchanges, which include temporary (up to one year), long-term (more than one year, but permanent) or permanent.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium-High
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- The wording of the indicator is too vague and would not provide a focused evaluation of the intended outcome.
- Another indicator (*HE 11, Volume of Water Transferred on the Open Market; Cost of Water on the Transfer Market*) has been identified that is a better representation of the intended outcome.

HE: Social Safety (Water used for Industry Instead of Agriculture)

This indicator would assess social safety through the evaluation of water use. Water tends to go to the highest economic use. The statewide water balance could be a good indicator of whether social safety is achieved by investigating the balance of industrial water use and agricultural water use.

Screening Process

Representative of Outcome:	Low
Data Viability:	Low
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Low

This indicator was archived for the following reasons:

- The data to assess this indicator are not viable. There are limited historical or spatial data throughout California.
- Food security within the state of California can't necessarily be directly linked to food production in California.

HE: [Gross Domestic Product]/[Consumptive Use]

This indicator would assess the ratio of the GDP verses consumptive water use. The GDP is one of the primary indicators used to gauge the health of a country's economy. It represents the total dollar value of all goods and services produced over a specific time period and reflects the size of the economy.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Low

This indicator was archived for the following reasons:

- Measuring GDP can be complicated, so obtaining viable data at the state level may be difficult.
- Water is not the only factor in economic productivity, so this indicator is not very representative of the intended outcome or societal value.

HE: Consumer Price Index vs. Aggregated Cost of Service

This indicator would assess the Consumer Price Index (CPI) versus the aggregated cost of services. The CPI is a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services. Aggregate cost of services are produced by averaging across all the costs of services related to consumer items.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium-High
Potential Longevity:	Medium
Supportive of Decision Making:	Low

This indicator was archived for the following reasons:

- There are likely data for urban water use through the U.S. Bureau of Labor Statistics, but data on agricultural water use may not exist.
- The CPI is designed to measure inflation for the urban population and may not accurately reflect populations living in more rural areas.
- The CPI surveys typically rely on the voluntary cooperation of many people and establishments throughout the state, which may result in some significant data gaps.

HE: Change in End Use (agriculture, urban, industrial, open space) Mapped

This indicator would assess the change in end use of water throughout the state. Although water may initially be a supply for agriculture, the end use could change to urban, industrial, or open space depending on where the demand is. Similar transfers could be made for water that was originally urban, industrial, or open space.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	Medium
Cost:	Low
Potential Longevity:	High
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- A change in the end use of water is neither good nor bad, so this indicator would not be very supportive of decision making.

- This indicator is archived for similar reasons as HE Land Use Changes – Agricultural/Urban/Industrial/Open Space.

HE: Five-year Rolling Average of Hydropower Generation vs. Total Generated

This indicator would assess the five-year rolling average of hydropower generations verses the total amount of energy generated statewide. Hydroelectric power is a major source of California's electricity. The amount of hydroelectricity produced varies each year, and is largely dependent on rainfall. A five-year rolling average would help normalize the variance caused by hydrologic effects.

Screening Process

Representative of Outcome:	Low-Medium
Data Viability:	High
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reason:

- The definition of this indicator is too vague, so it was replaced with *HE 12, Percent of Average Annual Power Demand Satisfied by Hydropower*, which is more specific and a better representation of the intended outcome.

Healthy Economy

Intended Outcome: Reduced likelihood or occurrence of significant social disruption following a disaster

HE: Number of Water-Related Emergency Declarations over Time

This indicator would assess the cumulative number of water-related emergency declarations over time. All emergency and major disaster declarations are made solely at the discretion of the President of the United States, when the President determines federal assistance is necessary.

Screening Process

Representative of Outcome:	Medium
Data Viability:	High
Cost:	Low
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reason:

- The data from this indicator would be potentially useful at a local or regional scale to consider trends, but the number of declarations themselves is not actionable or representative of the social disruption that would follow a disaster.

HE: Lost Business Income from Water-Related Emergency Declarations

This indicator would assess the lost business income due to water-related emergency declarations. Severe, prolonged droughts or even catastrophic events can have a negative financial impact on businesses that make it hard for them to return more quickly to normal operations. Disruption from water-related emergency declarations can lead to long-term impacts, such as a business's permanent inability to return to operations.

Screening Process

Representative of Outcome:	High
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- Although estimates have been collected for specific events in the past, data are not currently collected on lost business income due to water-related emergency declarations.

- Small businesses may be impacted more than larger businesses, which would make it less supportive of decision making when evaluating how to reduce the likelihood or occurrence of significant social disruption following a disaster.

Opportunities for Enriching Experience

Intended Outcome: Preserved or enhanced culturally or historically significant sites and communities, including continues and enhanced access to water and land used for sacred ceremonies or cultural practices

OEE: Number of Qualified Historical Buildings or Historic Places at Risk of Losing Reliable Water Supplies, or with Equal to or Greater than a 1 Percent Chance of Being Flooded in any Given Year

This indicator would assess what qualified historical buildings or places throughout California are at risk of losing reliable water supplies or are located in a 100-year floodplain. Most of California is vulnerable to floods and every county has been declared a flood disaster area multiple times. Therefore, it's not uncommon that many qualified historical buildings or places throughout California are impacted by the negative effects of flooding.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Low-Medium
Cost:	Medium
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- It would be difficult to track and estimate the water supply reliability to specific historical resources, which would make it difficult to provide a complete dataset for this indicator.
- There is not a current viable dataset and another indicator has been identified (*OEE 1, Number Historically and Culturally Significant Sites at Risk of Flooding or Sea Level Rise*) that provide a better representation of the intended outcome.

Opportunities for Enriching Experience

Intended Outcome: Preserved and increased natural areas with aesthetic or intrinsic value (including view shed)

The following indicators were combined to form an indicator (*OEE 2, Change in Natural Area*) that is more representative of the intended outcome. Each indicator received a relatively low score in the screening process because by themselves there were not indicative of the outcome. Together, they are valuable in assessing the aesthetic and intrinsic value of natural areas throughout California.

OEE: Statewide Open Space

Scale:	Statewide
Potential Data Sources:	State Lands Commission; California Coastal Commission; California Department of Conservation
Data Availability:	Type II
Metric:	Acres of Open Space
Screening Status:	Archive

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Low
Potential Longevity:	High
Supportive of Decision Making:	Medium

OEE: Conserved Lands Adjacent to California Waterways (acreage)

Scale:	Statewide
Potential Data Sources:	Unknown
Data Availability:	Type III
Metric:	Acreage of conserved lands
Screening Status:	Archive

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Medium
Potential Longevity:	High
Supportive of Decision Making:	Medium

OEE: Land Conservation Williamson Act Enrollment (acreage)

Scale:	Statewide
Potential Data Sources:	California Department of Conservation; DWR
Data Availability:	Type I
Metric:	Acreage of land enrolled in Williamson Act
Screening Status:	Archive

Screening Process

Representative of Outcome:	Medium
Data Viability:	Medium
Cost:	Low
Potential Longevity:	High
Supportive of Decision Making:	Medium

Opportunities for Enriching Experience

Intended Outcome: Continued and enhanced access to resources that support education and learning

No indicators considered during the planning process were archived for this intended outcome.

Opportunities for Enriching Experience

Intended Outcome: Continued and enhanced recreational opportunities in waterways, reservoirs, or natural and open spaces

OEE: Number of Communities Without Access to Water-related State Lands, Parks, or Resources

This indicator would assess the number of communities without access to water-related State lands, parks or other outdoor spaces. Although there are ample water-related State lands and parks throughout California, they may be inaccessible by some communities due to traveling barriers, long distances, or funding issues.

Screening Process

Representative of Outcome:	High
Data Viability:	Low
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Medium

This indicator was archived for the following reasons:

- The indicator would need redefined to be more representative of the intended outcome.
- All communities have access to State and local parks, but people in the communities may not be able to go due to personal restrictions such as distance, travel barriers, weather conditions, or funding issues. The information required to evaluate this indicator is not scientifically based.

OEE: Change in Water Bodies that Allow Contact Recreation

This indicator would assess how many water bodies that allow contact recreation have needed to change their regulations and inhibit contact recreation. Water bodies in California serve multiple functions, including drinking water supply or as a recreational waterbody. Some recreational water bodies may need to create regulations to prohibit contact recreation due to water quality concerns or if the purpose of a waterbody, such as a reservoir, is switched to a drinking water source for cities or communities.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Low-Medium
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- Although this indicator would be representative on a statewide scale, there are too many non-related reasons why water contact is not allowed in some water bodies.
- A reservoir that serves as a drinking water source does not reflect poor water quality issues, which could be another reason for prohibiting water contact in a reservoir.

OEE: Change in miles of Boatable (recreational) Waterways

This indicator would assess the change in square miles of boatable waterways.

Screening Process

Representative of Outcome:	Medium
Data Viability:	Low-Medium
Cost:	High
Potential Longevity:	Medium
Supportive of Decision Making:	Low-Medium

This indicator was archived for the following reasons:

- Technically, all waterways are considered “boatable”, so there would be no change to assess from this indicator.
- This indicator would require rephrasing to avoid misinterpretation because the term “boatable” is too vague.

7 Statewide Progress toward Sustainability Outlook

THIS SECTION IS CURRENTLY UNDER DEVELOPMENT

The intent of this section is to reflect the current status of the statewide evaluation of all Basic and Watershed Indicators to provide a preliminary assessment of California's progress towards sustainability and highlight potential next steps/recommendations for continued development of the Sustainability Outlook.

The evaluation is meant to provide a common framework that can be applied to individual California regions and watersheds. In addition, DWR intends to show both (1) the current state of sustainability, and (2) trends to highlight areas where progress has been made and areas where additional efforts may be needed.

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